Flathead Basin Commission

Biennial Report

December 1988

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1986 - 1988

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FLATHEAD BASIN COMMISSION

BIENNIAL REPORT

DECEMBER 31, 1988

FLATHEAD BASIN COMMISSION

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To: MEMBERS OF THE FIFTY-FIRST MONTANA LEGISLATURE

This Biennial Report serves as a summary of recent Flathead Basin Commission activities. It also includes recommendations regarding the preservation of the high quality of the basin's aquatic resources. Previous Flathead Basin Commission publications included reports to the legislature distributed in 1985 and 1986 and the proceedings of a conference entitled, "Our Clean Water: Flathead's Resource of the Future," published in 1988.

The Flathead Basin Commission was created by the 1983 Legislature to "protect the existing high quality of the Flathead Lake aquatic environment; the waters that flow into, out of, or are tributary to the lake; and the natural resources and environment of the Flathead Basin."

Duties of the Commission include:

- monitoring the basin's natural resources
- encouraging cooperation among basin land managers
- supporting economic development without compromising the basin's aquatic systems
- making recommendations to the legislature regarding the preservation of the basin's aquatic resources
- promoting cooperation between Montana and British Columbia on resource development in the Flathead Basin

Please don't hesitate to contact a Commission member should you have questions regarding the Flathead Basin Commission and its activities.

Sincerely,

Brace Hayden

Brace Hayden
Executive Director

ACKNOWLEDGMENTS

The Flathead Basin Commission wishes to thank all of the individuals who prepared portions of this report. These included Commission members Brace Hayden, Steve Pilcher, and Jerry Sorenson; Carole Schmidt and Ralph Driear of the Governor's Office; the Commission's Public Education Coordinator, Craig Hess; Dr. Jack Stanford, Dr. Rich Hauer, and Bonnie Ellis, of the Flathead Lake Biological Station; Loren Bahls and Scott Anderson of the DHES-Water Quality Bureau; and John Fraley and Laney Hanzel of the Department of Fish, Wildlife and Parks. We also wish to thank the many individuals whose earlier efforts are extensively referenced in the report, including all of the agency and industry scientists who contributed to the monitoring program. The patience and skill of Ronni Burke, Jennifer Lewis, Carol Smith, and Sue Gillespie, who typed portions of the report, are gratefully acknowledged. Lastly, Carole Schmidt is deserving of special recognition for her careful and timely editing of the manuscript.

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INTRODUCTION

The Flathead Basin Commission (FBC) was created by the 1983 Montana Legislature to "protect the existing high quality of the Flathead Lake aquatic environment; the waters that flow into, out of, or are tributary to the lake; and the natural resources and environment of the Flathead Basin."

Duties of the FBC include:

- monitoring the basin's natural resources
- encouraging cooperation among basin land managers
- holding public hearings on the environmental and economic conditions of the basin
- supporting economic development without compromising the basin's aquatic systems
- making recommendations to the legislature regarding the preservation of the basin's aquatic resources
- promoting cooperation between Montana and British Columbia on resource development in the Flathead Basin.

The Flathead Basin Commission is currently composed of seventeen individuals. These include state, federal, tribal, and Canadian land and water managers, water protection agencies, a utility company, and four appointees of the Governor. One of these appointees is a member of the Governor's staff and serves as the Executive Director of the FBC.

This Biennial Report serves as a summary of recent activities and also includes report recommendations regarding the preservation of the high quality of the basin's aquatic resources. It is intended to satisfy the reporting requirements of 75-7-30 MCA. Previous Flathead Basin Commission publications included reports to the legislature distributed in 1985 and 1986 and the proceedings of a conference entitled, "Our Clean Water: Flathead's Resource of the Future," published in 1988.

The FBC has been instrumental in establishing and seeking funding for a water quality monitoring program in the Flathead Basin. This program is designed to integrate water quality monitoring efforts by area agencies, provide an assessment of changes in water quality, and identify the probable reasons for such changes. Chapter 1 synthesizes the results of recent monitoring efforts conducted pursuant to the monitoring program and concludes that in general, the waters of the Flathead remain in very good condition, but significant water quality problems are apparent.

Chapter 2 describes the steady progress being made towards implementation of a strategy for limiting phosphorus levels in Flathead Lake. This six-point strategy was designed by the Montana Department of Health and Environmental Sciences in 1984 and is strongly endorsed by the FBC. Since January 1987, both Flathead and Lake counties have had a county restriction on the sale of phosphorus-based laundry detergents in place. Phosphorus input into the lake is also being reduced by a state-imposed requirement that area wastewater treatment plants upgrade their effluents to achieve phosphorus removal to a maximum discharge amount of 1 milligram per liter (mg/l).

As of December 1988, the communities of Bigfork, Columbia Falls, and Whitefish had all installed tertiary wastewater treatment and were meeting the 1 mg/l phosphorus limit. Kalispell has yet to comply with the 1 mg/l standard, but is currently planning for substantial renovation to its plant, including interim phosphorus removal while the plant is being reconstructed.

Other elements of the strategy where progress can be noted include the construction of new or expanded wastewater treatment systems in several basin communities, and new initiatives to better define and therefore address the problem of nonpoint source pollution. One of these is an FBC-sponsored effort described in Chapter 3, wherein research is being initiated to better document the relationship between forest practices, water quality, and fisheries in the Flathead River Basin.

The Flathead Basin Commission has also recently started to work towards solutions to such problems as the conflicts inherent in the management of Flathead Lake's water levels and the need for effective land use planning in the valley. Chapter 6 presents an assessment of the water level issue, including a summary of possible mitigation efforts. Future biennial reports will likely focus on the planning issue.

In late 1986 the FBC began a formal public education effort regarding threats to the basin's water quality. In establishing this program, the FBC recognized that land management and regulatory agencies have identified actions that need to be taken to protect the Flathead's water resources. Strong public understanding, and hence support, is what is now needed if these water management decisions are to be implemented. Chapter 4 describes the various elements of the FBC's Public Education Program, including brochures, slide shows, and other presentations available from the FBC. Building public support for protecting basin waters is one of the FBC's primary objectives.

Changes in land use and development trends are important indicators of the Flathead's economy and character. Land use activities also impact air and water quality, wildlife habitat, and other resource values. Chapter 5 describes recent trends in population growth, housing construction, and land division in the basin. Two ongoing economic development initiatives in the Flathead area are described in Chapter 7.

In September 1988 the FBC voted to oppose the Cabin Creek coal mine in British Columbia. The primary reason for this vote was the FBC does not believe that the impacts of the mine, as detailed in the International Joint Commission (IJC) Investigative Board's report, are sufficiently mitigable to protect the water quality and fishery in the North Fork of the Flathead River. Furthermore, the FBC believes that development of this mine in such close proximity to Waterton-Glacier Park violates the important economic and ecological values that this area represents to the United States and Canada. The summary and conclusions from the Investigative Board's report are included in Appendix E. Appendix F is the FBC's testimony regarding the findings in this report that were presented to the IJC.

At the conclusion of the two-day water conference sponsored by the FBC in the spring of 1988, its attendees were asked to tell the FBC where it should concentrate its future efforts. Recommendations included: expand the membership base of the FBC; develop a funding program that places a greater share of the FBC program costs on the Flathead Basin citizens; continue the FBC's existing role of providing people with current and accurate information regarding the water issues in the basin; provide support for responsible land use planning in the basin; and continue the FBC's efforts to evaluate the condition of the basin's water quality. These recommendations represent the Flathead Basin Commission's blueprint for its activities during the coming biennium.

CHAPTER 1

Water Quality Monitoring in the Flathead Basin[1]

EXECUTIVE SUMMARY

One of the missions of the Flathead Basin Commission (FBC) is to coordinate the collection of water quality monitoring data within the Flathead River Basin. The purpose of this effort is to provide the public with periodic status reports about changes in variables that characterize waters of the Flathead. The program also coordinates interagency data and information transfer, which is a vital aspect of system-wide management and conservation of the Flathead's natural resources.

This report is a synthesis of water quality monitoring data collected by State and Federal management agencies and the Flathead Lake Biological Station (University of Montana) through 1987. The data pertain only to surface waters. While the FBC recognizes the importance of maintaining clean groundwaters, the monitoring program has so far only considered lakes, streams, and precipitation. Analyses of trends through time were done for important variables that describe the quality of water in the Flathead.

The analyses showed that in general, the waters of the Flathead remain in very good condition. Much of the basin's waters are as pure and pristine as any on the globe. Because of relatively inert soils and bedrocks and lack of significant human disturbance, the streams and lakes in Glacier National Park contain few dissolved solids. For example, Gyrfalcon Lake, a high-elevation lake with a very small catchment, is little more than an accumulation of sterile rain water. Very high quality water in alpine lakes and streams also indicates that precipitation in the Park is of high quality and without traces of acidity or other pollutants that characterize many areas of the U.S. Waters draining other areas of the basin naturally contain much higher amounts of dissolved solids, reflecting the higher mineral content of the soils and bedrocks. Pollutants appear to be minimal and the indigenous biota include species that are indicators of clean, cold, and well-oxygenated conditions.

1 This chapter of the biennial report was compiled and edited for the Flathead Basin Commission by Jack Stanford of the Flathead Lake Biological Station. The report was based on annual reports on water quality monitoring prepared by the Flathead Lake Biological Station, the Montana Department of Fish, Wildlife and Parks, the Montana Department of State Lands, and the Flathead National Forest. It is the FBC's intent to prepare similar biennial updates on the status of water quality in the basin.

As an example, bull trout, a native salmonid which in most other systems has been severely impacted by pollution, remain abundant in the Flathead; and, monitoring data suggest that bull trout reproduction is healthy and stable.

However, some water quality problems were apparent in the monitoring data. Some of these problems were noted in previous studies in the basin, but the FBC monitoring program has allowed a more quantitative and whole-basin perspective.

First and foremost, anthropogenic manipulation of river flow and lake levels by Kerr and Hungry Horse Dams continues to exert the most profound effects on water quality. Fluctuating discharges related to hydropower production have altered thermal regimes and erratically reduced flows to the extent that indigenous biota, including important sport fishes, cannot successfully reproduce. Impoundment and flow regulation also influence chemical dynamics in the system. Kerr Dam, coupled with controlled flows from Hungry Horse Reservoir, permits Flathead Lake to be held at full pool for about half the year. As a result, wave-induced erosion and saturation of riparian soils has altered the configuration and ecology of the lakeshore, as well as causing increased turbidity and nutrient enrichment of nearshore areas in the lake.

Second, the monitoring data so far suggest that the quality of water in Flathead Lake has not improved. Previous studies showed that this relatively pristine lake was being polluted by high concentrations of plant growth nutrients in effluents from the urban sewage treatment plants. The result was increased production of algal species commonly found in polluted lakes. Indeed, the monitoring data show that primary production (of algae) has increased steadily since 1977, which may be interpreted as a steady decline in water quality in the lake. This trend may be reversed by very recent and ongoing improvements in sewage treatment and implementation of other nutrient control strategies as mandated by the State's Water Quality Bureau. For example, monitoring data clearly show that the amounts of phosphorus (an important algae growth stimulant) that reached the sewage treatment plants have been substantially reduced, due to a ban on the sale of phosphorus-containing detergents. Reductions in amounts reaching Flathead Lake may eventuate as soon as new chemical equilibria are reached in the various streams (e.g., Ashley Creek) that carry sewage effluents into the lake.

A third concern relates to changes in stream and lake food webs manifested or influenced by introductions of exotic biota. For example, the monitoring program has clearly documented the establishment of the opossum shrimp (*Mysis*) in Flathead Lake and concurrent declines in important zooplankton and fish species. The interrelations between these events are not clearly understood and underscore the interactive nature of most water quality problems.

The proposed Cabin Creek coal mine on the North Fork of the Flathead River in Canada, if developed, could become a serious water quality problem. Indeed, the Board Report of the International Joint Commission reference on potential mine impacts concluded that the North Fork of the Flathead River, which is an important part of the Glacier - Waterton International Biosphere Reserve, would be polluted by sediments and nutrients and up to 10 percent of the basin's bull trout would be lost if the mine were developed.

Other potential water quality problems are being addressed by the FBC through the monitoring process. For example, the cumulative, nonpoint source impacts of forest development and the effectiveness of "best management practices" on water quality in streams continues to be a controversy that requires an assessment of objective monitoring data for their ultimate resolution. Under the FBC's monitoring program, empirical data are being gathered in a cooperative fashion to allow agencies to relate various forest practices to variations in water quality.

The FBC water quality monitoring program is vital to effective management of natural resources in the Flathead Basin. The FBC recognizes that the waters of the Flathead in essence integrate the natural and deleterious effects of various land uses. Thus, the environmental health of the entire basin is reflected in its waters. Moreover, maintenance of high quality water is a vital economic aspect of the Flathead Basin. The status of water quality cannot be quantified without ongoing monitoring. Refinement and expansion of the monitoring program seems warranted.

INTRODUCTION

In 1969 a seminal workshop was held at Flathead Lake to discuss the future development of Montana's natural resources; development of water resources and associated impacts on water quality were included in the agenda. The great value of the State's many pure rivers and lakes was recognized, including those of the Flathead Basin. However, concerns were expressed over the potentially negative impacts of logging activities, urban development, stream flow and lake-level regulation, and expansion of tourism and recreation-based businesses, among other things. Few quantitative solutions were forthcoming, but the workshop was successful in focusing attention on the fact that proper development and management of natural resources requires foresight and cooperation among the many State and Federal agencies with natural resource management jurisdictions in the State (Schoonover 1969).

Initiated by concerns over a proposed coal strip mine in the British Columbia headwaters of the North Fork of the Flathead River, a basinwide environmental assessment of water quality and aquatic biota was completed during the period 1978 - 1984. Known as the Flathead River Basin Environmental Impact Study (FRBEIS), a variety of studies were completed which for the first time carefully documented the limnology and fisheries of the basin. The results of these objective research projects were summarized in a final report by the study's steering committee (Zackheim and Cooper 1983). It was concluded that waters of the basin remained generally very pure and of high quality; and, data obtained in the study established a quantitative baseline from which future changes could be evaluated. But, perhaps more importantly, the report demonstrated that the pristine nature of the basin's water and associated biota were being negatively impacted by 1) excessive nutrient loading from urban and household sewage disposal systems, especially in Flathead Lake, and 2) environmental stress induced by stream flows and lake levels artificially manipulated by the two hydroelectric dams in the basin. Other threats to water quality were listed (e.g. acid precipitation) but not substantiated in the report; in particular, concerns included increased sedimentation and temperature alterations associated with deforestation and road building and the cumulative downstream impacts associated with the development of the proposed coal mine.

In 1983 the Flathead Basin Commission (FBC) was created by the Montana State Legislature to continue the conservation-oriented activities of the FRBEIS and to coordinate interagency and public discussion of various resource management options and concerns. A major goal of the FBC has been to expand the interagency water quality data base begun by the FRBEIS in 1978. Thus, a Master Plan for Monitoring Water Quality in the Flathead River Basin was adopted by the Commission (FBC 1986) and data collections are continuing.

Water quality monitoring tasks specified under the auspices of the FBC's Master Plan (FBC 1986) included time-series measurement of biophysical variables (e.g. discharge, temperature, dissolved solids concentrations, suspended solids concentrations, primary production, numbers of spawning fishes) that may best be used to quantitatively describe the quality of water. The FBC did not formally define "water quality"; but, in the terms of past studies (e.g. Zackheim and Cooper 1983), "water quality" includes water volume and chemical concentrations, physical aspects of stream and lake habitats, attributes of key biota (e.g. bull and cutthroat trout) that require pristine,

unpolluted water and measured deviations of these variables from normal or baseline conditions. Biophysical data required by the Master Plan are obtained by the various resource management agencies within the Flathead Basin or they have provided funding to the Flathead Lake Biological Station (University of Montana) to do the work (Table 1). Each agency files an annual report of its data to the FBC, complete with appropriate time-series (trend) analyses and a bibliography of recent reports related to or containing additional water quality measures.

This report summarizes the agency reports for 1987 (Page 1987, Schultz 1987, Stanford and Ellis 1988, Vashro 1987) and describes the present status of water quality within the Flathead Basin; where appropriate, reference is made to the results and conclusions of other studies on water quality in the Flathead Basin or elsewhere. Also included as Appendix I is a bibliography of papers produced since the FRBEIS (Zackheim and Cooper 1983) and which are germane to the management of water resources in the basin.

Table 1. Resource management agencies involved in the collection of data under the auspices of the Master Plan for Monitoring Water Quality in the Flathead Basin (FBC 1986).

Resource Management Agency	Primary Task
Montana Department of Fish, Wildlife and Parks	Fisheries inventories
United States Forest Service	Stream physicochemistry
Montana Department of State Lands[1]	Stream physicochemistry
United States Geological Survey	Hydrological measures
National Park Service	Glacier Lakes limnology[a]
Montana Department of Health and Environmental Sciences, Water Quality Bureau	Flathead Lake limnology[a]
Confederated Salish and Kootenai Tribes	Flathead Lake limnology[a]
Montana Power Company	Flathead Lake limnology[a]
Flathead County	Flathead Lake limnology[a]
Lake County	Flathead Lake limnology[a]

[1] Plum Creek Timber, Inc. paid for monitoring by DSL on Lazy Creek in the Swift Creek catchment

[a] contracted to Flathead Lake Biological Station (University of Montana)

STUDY AREA

The Flathead Basin encompasses 22,241 km^2 (8,587 mi^2) in northwestern Montana and southeastern British Columbia (Fig. 1). The Flathead River at Flathead Lake is a sixth order river with a mean discharge of 350 m^3/sec (12,360 ft^3/sec). Thus, the hydraulic retention time of 496 km^2 (192 mi^2) Flathead Lake is less than 3 years (Stanford et al. 1983); other large lakes in the basin (Fig. 1) are also dramatically influenced by inflowing streams (e.g. Whitefish Lake, Golnar 1985). As a consequence, the limnology of the large lakes tends to reflect or integrate upstream land-use patterns. For example, all of them receive overflow turbidity plumes during spring runoff,

or in association with spates, as flooding tributary streams erode their banks. The sediment plumes contain higher concentrations of plant growth nutrients than normally exist in the water column of the lakes; and, thus, the plumes tend to fertilize the lakes. A myriad of streams exist in the basin drainage network and water quality is related to the particular geologic landscapes of each stream catchment. In general, streams and lakes in Glacier National Park tend to be very low in dissolved solids, owing to the relatively inert nature of the Precambrian argillite (siltite) mudstones that dominate the substrata. Conversely, streams draining the Canadian portions of the North Fork and the montane areas south of the Park incise Mesozoic limestones and are well buffered (Zackheim and Cooper 1983). Most of the waters of the Flathead are derived from snowmelt in the mountains, although the valley bottoms average about 50 cm of precipitation per year (Stanford et al. 1983).

A remarkably diverse biota characterizes the Flathead River system. For example, over 300 species of aquatic insects (mayflies, caddisflies, stoneflies and true flies) occur in the mainstem river. Each insect species displays a distinct pattern of resource use, behavioral adaptation and timing of development (particularly in response to temperature) which permits coexistence with other species at the same location (Stanford et al. 1988). At a single sampling site on the Flathead River near Kalispell, 40 species of stoneflies and over 30 species of caddisflies have been collected. Twenty-two native and introduced fishes reside in the Flathead drainage. Bull trout (Salvelinus confluentus) and westslope cutthroat trout (Salmo clarki lewisi) are the most highly prized of the native sport fishes, while kokanee salmon (Oncorhynchus nerka) and lake trout (Salvelinus namaycush) are popular introduced species (Lenihan and Johnson 1987, Zackheim and Cooper 1983). Lake whitefish and yellow perch, both nonnative species, are also of increasing interest to fishermen in Flathead Lake. Of the 45 million fish introduced into Glacier National Park from 1912 to 1960, most were Yellowstone cutthroat trout (Salmo clarki bouvieri), though many rainbow trout (Salmo gairdneri) were also stocked. Hybridization of native westslope cutthroat trout with these two related fishes is a major concern in efforts to maintain the indigenous fishes in the Park (Marnell et al. 1987).

While the aquatic biota of the basin is notably unique and quite diverse (i.e. many different plants and animals coexist), individual populations are not normally abundant, owing to the generally sterile nature of the basin's waters. This feature is a particularly important aspect of water quality management in the Flathead Basin. The naturally sterile surface waters in the Flathead are relatively devoid of plant growth nutrients, such as nitrogen and phosphorus. Thus, production of algae and other plants is naturally nutrient-limited; and, consumers higher in the food chain, like insects and fish, do not have enough of a plant base to become very abundant. Indeed, most of the streams and lakes in the basin, including Flathead Lake, seem clear and clean because there are too few nutrients in these waters to allow luxuriant growths of algae and bacteria that characterize richer or polluted waters elsewhere. Thus, in the Flathead there appears to be a delicate balance between nutrient supply and biotic diversity; the native species are highly adapted to low levels of plant growth nutrients and no single consumer species can outcompete the others for available forage. Over the millennia this has allowed a large number of species, none of them very abundant, to coexist. Anything that upsets this delicate balance between low nutrient supply and a diverse biota, such as nutrient pollution from sewage,

overharvest of sport fishes or introduction of exotic plants (e.g. loosestrife and other weeds) and animals (e.g. *Mysis*, discussed below), is a legitimate threat to water quality in the basin.

Another important feature of the Flathead system concerns the fact that many of the native fishes (e.g. bull and westslope cutthroat trout) and some of the introduced species (e.g. kokanee salmon) are adfluvial. That is, they mature in the large lakes, particularly Flathead and Swan Lakes and Hungry Horse Reservoir, but migrate upstream into the rivers and tributary creeks to spawn. The eggs hatch and the fry or juvenile fishes migrate back downstream to the lakes to grow to maturity. This is a particularly important feature of the Flathead system. Water quality in the lakes is derived from high quality waters in the catchment. Likewise, the ability of fishes to maintain healthy populations in the lakes is dependent on high quality waters in the tributary streams where these fishes spawn. Thus, localized pollution in even a very few tributaries may compromise water quality in the lakes by interfering with adfluvial spawning success.

Major anthropogenic features of the basin that directly or indirectly impact water quality include: Kerr and Hungry Horse Dams (both are hydroelectric facilities); urban areas intermixed within the agricultural land base of the Kalispell Valley; extensive logging and road building in the forested areas not included in Glacier Park and adjacent wilderness areas; the largely pastoral setting of the Flathead Indian Reservation; and, land disturbances associated with exploratory drilling at and near the proposed Cabin Creek coal mine site on the North Fork (Fig. 1). However, there are no heavy industries in the basin that have point source discharges of pollutants; point sources of concern to water quality considerations are apparently limited to urban sewage systems and a few localized sites contaminated by organic toxins (e.g. Somers creosote pit).

METHODS

Limnology

The sites discussed in this report (Fig. 1) were selected from an array of over 50 sites monitored by the FBC (1986). The selected sites represent the full spectrum of streams and lakes from high in the headwaters to Flathead Lake (Fig. 1). Only sites with a multiyear data base were selected in order to permit analysis of temporal trends. These sites also illustrate a spectrum of water quality, from pristine (e.g. Gyrfalcon Lake) to highly polluted (e.g. Ashley Creek). People wanting data or interpretations from monitoring sites not discussed herein should contact specific agencies charged with the monitoring tasks at sites in question (see FBC 1986).

Data were collected in time-series and under the guidelines and prioritizations given in the Master Plan (FBC 1986). In general this means that samples (e.g. for chemical constituents) or biological data (e.g. primary production) were gathered about monthly, although the sampling frequency at most sites increased to biweekly during the spring runoff. Samples were maintained on ice or field filtered and frozen as appropriate. For some variables, such as temperature and discharge, data were obtained with

continuous recorders. In some cases stream flow was determined by either direct measurements or by interpolation from a rating curve developed for specific sites.

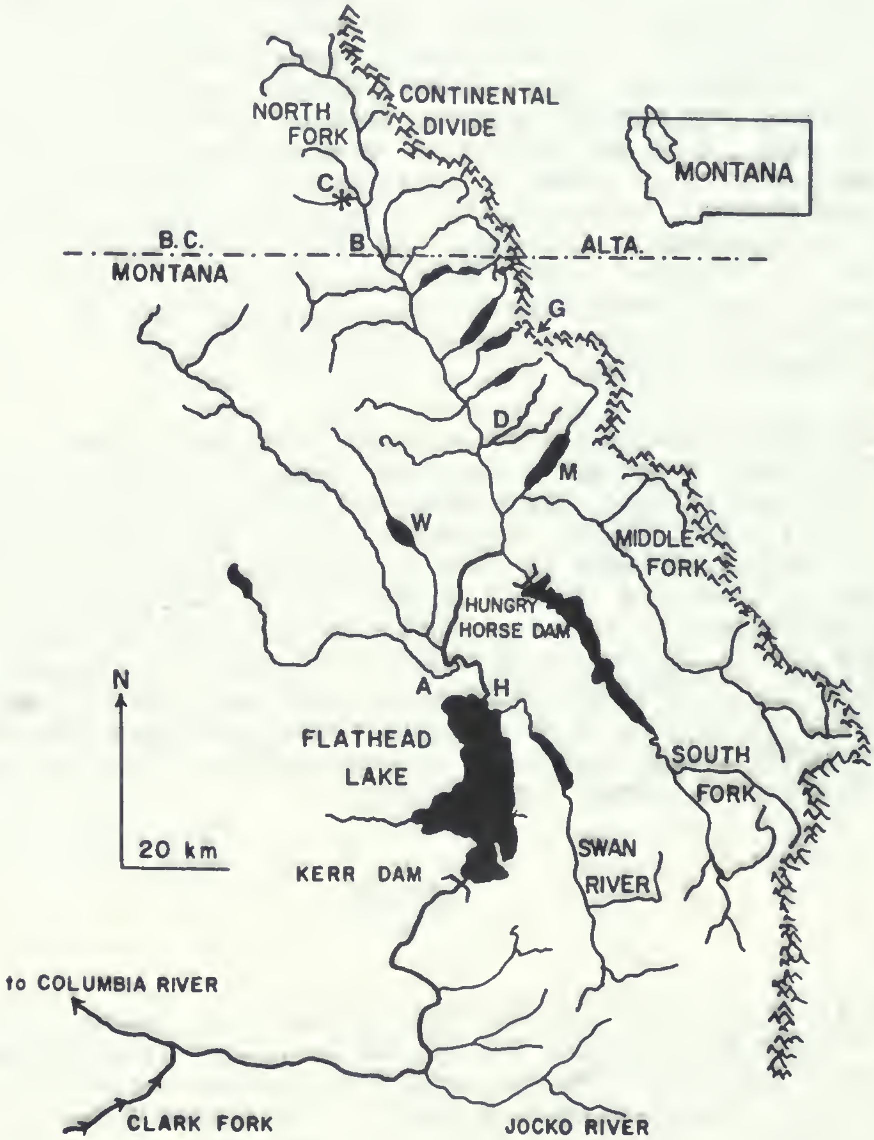

Figure 1. The Flathead River Basin showing the major tributaries contributing water to Flathead Lake and the lower Flathead River confluence with the Clark Fork of the Columbia. Locations of selected lakes and streams referred to in this report are shown by G (Gyrfalcon Lake), M (McDonald Lake), W (Whitefish Lake), D (Dutch Creek), C (Cabin Creek), B (North Fork of the Flathead River at the Border), H (Flathead River at Holt) and A (Ashley Creek). Note the site (*) of the proposed coal strip mine near Cabin Creek, a tributary of the North Fork of the Flathead River in British Columbia. The proposed mine has been the subject of a recent analysis of potential water quality impacts associated with mine development and operation (Biological Resources Committee 1987, Water Quality and Quantity Committee 1987).

Analytical methods for chemical constituents (i.e. specific conductance (cond), soluble reactive phosphorus (SRP), soluble phosphorus (SP), nitrate-nitrogen (NO_3-N), ammonium-nitrogen (NH_3-N), total phosphorus (TP) and total nitrogen (TN) were as in American Public Health Association (1985) or as modified by Stanford et al. (unpubl. manual, Flathead Lake Biological Station, University of Montana). Analytical analyses were done either by the Freshwater Research Laboratory, Flathead Lake Biological Station (Page 1987, Stanford and Ellis 1988) or the Chemistry Department, University of Montana (Schultz 1987). For the former lab, quality control criteria for rejection of analyses were: 100 $\pm$ 10 percent of sample spikes and <1 standard deviation of the mean of replicated analyses. These checks were run on about every 10th field sample. In addition, laboratory performance evaluations were made about every 6 months using sample standards and unknowns from the U.S. Environmental Protection Agency. Reports of these evaluations were archived at the Biological Station.

Biophysical data included time-series measurements of secchi depth, a measure of water transparency, and phytoplankton primary production, as determined by the photosynthetic uptake rates of $^{14}CO_2$ in light and dark bottles incubated in situ (methods as given by Stanford et al. 1983).

Fisheries

Population densities of key sport fishes were monitored in selected basin streams and in Flathead Lake as a part of the water quality monitoring effort (FBC 1986). These inventories were done by the Montana Department of Fish, Wildlife and Parks.

Bull trout populations were monitored by counting redds (i.e. spawning nests) in important spawning streams and by estimating numbers of juvenile fish present in nursery streams from electrofishing surveys.

Numbers of adult westslope cutthroat trout were also determined from electrofishing surveys in several key streams (i.e. Coal and Hungry Horse Creeks) (methods given in May and Weaver 1987).

Spawning populations of kokanee salmon were monitored by visual counts made by divers in McDonald Creek below McDonald Lake in Glacier National Park (Fraley et al. 1986). McDonald Creek is now the primary spawning site for kokanee in the basin (discussed below).

Population density estimates of kokanee 8 inches (203 mm) and larger in Flathead Lake were made in August and early September each year using the hydroacoustical technique and transects described by Hanzel (1984). The retirement of the MDFWP research boat during July, 1985 required the collection of acoustical data with a portable acoustic system aboard a 24-foot jet powered boat. A new sounder (BioSonic Model 105) was used to collect the 1986 and 1987 acoustical data. The use of the jet boat did not allow midwater trawling, thus there was no concurrent verification of fish size to acoustic signal strength. Fish sizes were established by using the last verified trawl data collected during the fall of 1984. Creel checks were made to obtain scale and otolith collections that were used to establish ages of the fish. Mature kokanee were also collected by gill nets, beach seines and

electrofishing. Calculations of the weighted average of salmon numbers in various age classes were accomplished with the aid of the computer program described by Hanzel (1984).

Data Storage

The FBC instructed agencies to archive all Master Plan data in ASCII format in a computer file at the Biological Station. With the exception of fisheries data compiled by the Montana Department of Fish, Wildlife and Parks, all data were archived as planned. Fisheries data were archived in MDFWP computer files in Bozeman, Montana.

RESULTS AND DISCUSSION

Hydrographs, Thermal Patterns and Consequences of Volume Regulation

Streams and lakes of the Flathead River Basin characteristically exhibited hydrologic variation that was annually very predictable. High volume discharge occurred in the months of April - July, as snowpack in the headwaters was melted by warming temperatures; and, minimum volume occurred in December - January coincident with winter freeze-up. Hydrographs at all sites showed that unpredictable spates, due to intense rainfall or chinook thaws, may occur at most anytime. But, these tended to be short-term events, lasting a week or two and not altering the general pattern of spring high to midwinter low (e.g. Fig. 2).

A long-term hydrologic data set exists for the Flathead. At some sites the record exceeds 90 years. The data were not thoroughly analyzed here or in other studies (cf. Zackheim and Cooper 1983), especially with respect to global climate patterns (e.g. in response to El Nino events) or in relation to changes in land-use patterns (e.g. deforestation, Enk et al. 1985).

However, some important consequences of several decades of stream and lake regulation by the two dams, Kerr and Hungry Horse, were documented and are summarized here. Stream and lake level regulation has eliminated the annual amplitude (range) of discharge in the South Fork of the Flathead River (Ward and Stanford 1979, 1982), reduced annual amplitude and dramatically increased short-term fluctuations in the mainstem Flathead River above Flathead Lake (Perry 1984) and below Kerr Dam (Cross et al. 1987), and changed the timing and duration of "full pool" in Flathead Lake (Stanford et al. 1983).

The biophysical effects of stream regulation by the dams received considerable study and are described in detail elsewhere (Fraley and Graham 1982, Fraley et al. 1986, Hauer and Stanford 1982a, 1982b, 1986, Perry et al. 1986, 1987, Zackheim and Cooper 1983). Two aspects are important to the present discussion of water quality, however.

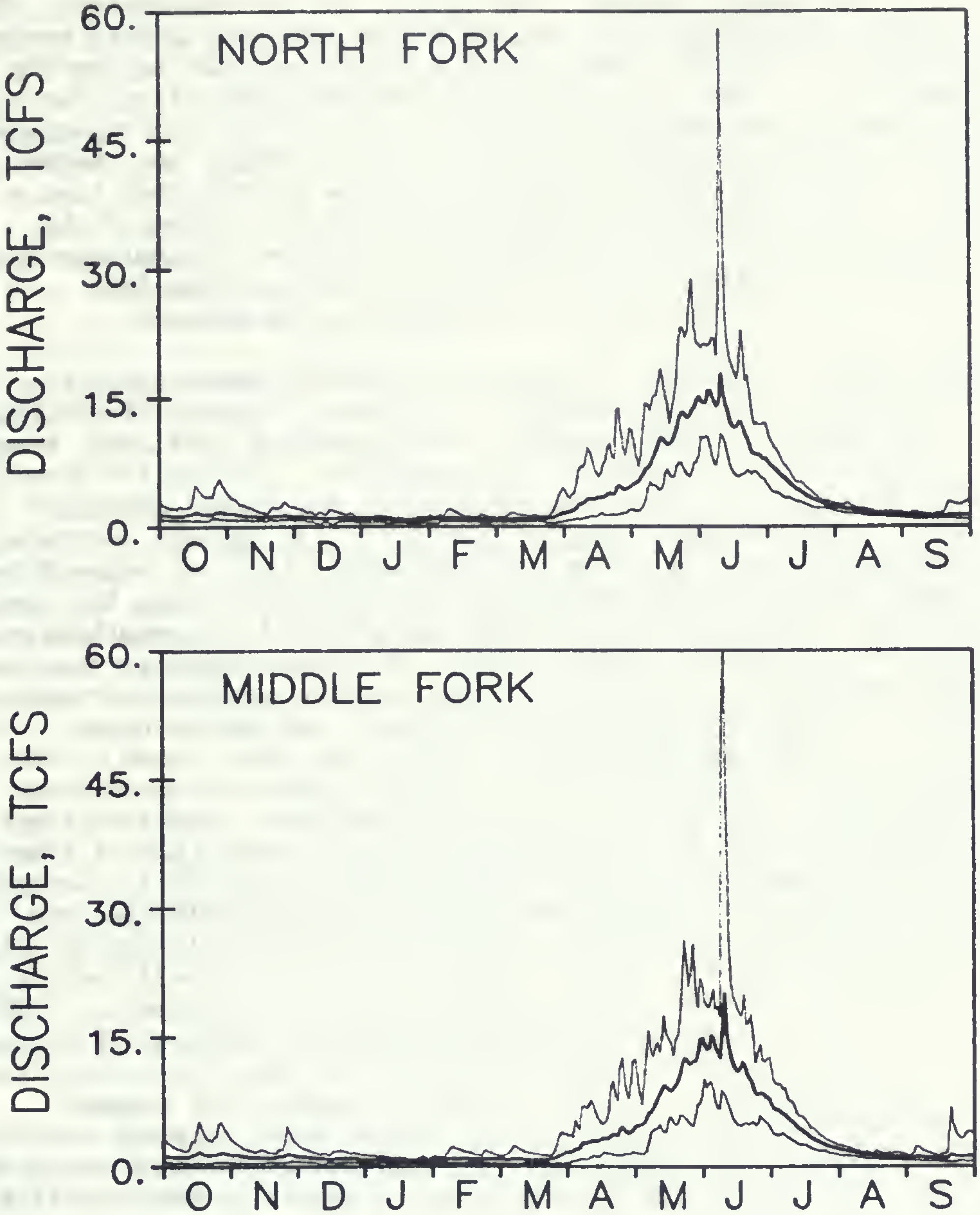

Figure 2. Maximum, minimum and mean discharge in the North Fork and Middle Fork of the Flathead River for water years 1960 through 1969. Data are monthly averages in thousands of cubic feet per second; to obtain m^3/sec multiply by 28.3. Maximum values in June are the highest on record and resulted from the 1964 flood (from Stanford and Ellis 1988).

First, it is important to understand why and how stream temperature regimes have been altered by stream regulation. Because of the inherent predictability of natural hydrographs (i.e. flow pattern, not necessarily annual yield), temperature dynamics are also predictably "seasonal" in the unregulated streams. Summer hypolimnial (bottom) discharges from Hungry Horse Dam greatly cool the riverine environments downstream; whereas, winter releases warm the water and prevent it from freezing. The overall effect is

to create a more seasonally constant, but colder, thermal environment. This has greatly altered the annual heat budgets of the regulated stream reaches. Indeed, Stanford et al. (1988) demonstrated a linear relation accurately predicting annual degree days as a function of stream order (size) for the unregulated streams in the basin. They also quantified how the relationship changed as a consequence of stream regulation. For example, the thermal environment in the South Fork below Hungry Horse Dam is very much like a first order, lowland springbrook because temperatures from the bottom of the reservoir are very constant (in spite of short-term flow fluctuations by the hydropower operations of the dam), much like the aquifers that feed springbrooks (e.g. Roy's Creek on the Biological Station grounds).

The second point involves the response of stream organisms to the altered discharge and associated temperature regimes. Because stream biota are mostly poikilothermic (cold-blooded), their metabolic rate, and, hence, growth and reproduction, is dependent on temperature. Cooling the annual heat budget, owing to the effects of stream regulation, may stress organisms to the point that they cannot successfully complete their life cycles. Conversely, if the mode of regulation is a surface-release system (e.g. as below Kerr Dam), the downstream environment may be abnormally heated during the summer (due to the heat storage effect of the lake surface) and the resulting regime may be too warm for the natural stream biota. The bottom line is that the natural stream community is altered to the extent that the thermal regime is altered. Indeed, the South Fork below the dam contains mainly biota characteristic of a cold springbrook (Stanford et al. 1988), most of the native biota has been extirpated and biota characteristic of lower order streams have colonized. Likewise, biota in the partially regulated segments (i.e. the mainstem Flathead below the South Fork confluence) are at times thermally stressed (Hauer and Stanford 1982a, Perry et al. 1987). Certainly other impacts of stream regulation have influenced the distribution and abundance of lotic biota (e.g. dewatering of fish redds, Fraley et al. (1986); armouring of substrata, Perry (1984); alteration of quantity and quality of seston food sources, Hauer and Stanford (1982a), Valett and Stanford (1987)). However, natural thermal regimes are fundamental to the survival of most aquatic biota, whereas, other disturbances exert secondary (but also often stressful or lethal) effects. In this context the effects of stream regulation must be viewed as negative and a severe threat to water quality, especially since regulation regimes have and will likely continue to change erratically over time in response to variables unrelated to water quality (e.g. economics of hydropower in the Bonneville grid; recreation demands in the Lower Columbia reservoirs).

Alteration of the Flathead Lake hydrograph has exerted direct effects on water quality. Over 50 years of lake level regulation (i.e. spring floodwaters are held in the lake through late fall for gradual winter release for hydropower) by Kerr Dam has completely reconfigured shoreline biophysical features, owing to shoreline erosion and elevation of the shoreline water table resulting from the abnormal temporal extension of "full pool" (Hauer et al. 1988).

Recent work by Carolyn Bauman (Flathead Lake Biological Station, University of Montana, M.S. thesis) demonstrated that lake level regulation may contribute to abnormal growths of algae on the shoreline; the full pool period exists long enough for a heavy periphyton biomass to accumulate and the dewatering process apparently allows oxidation of the previous year's crop,

providing nutrient rich substrata for periphyton propagules to readily use and begin the cycle again upon refilling of the lake in the spring. This process may be cumulative and synergistically interactive with increasing lake fertility (Stanford et al. 1983) and probably explains why the "ring (of periphyton) around the lake" seems to shoreline residents to have increased dramatically in the last two decades. Unregulated lakes in the basin (e.g. Whitefish, McDonald, Gyrfalcon) fill to full pool during spring runoff but decline quickly to an equilibrium shoreline; the abnormal periphyton community, described here for Flathead Lake, either has no time to develop or is more nutrient-limited (or both) in the nonregulated lakes of the basin. All of our lakes have characteristic, natural periphyton communities. Indeed, the shoreline of ultraoligotrophic Gyrfalcon Lake is matted with Cladophora gyrfalconium, a rare green alga adapted to high light and extreme nutrient limitation (Stanford and Prescott 1988). However, it grows very slowly and must be viewed as an indicator of extremely good water quality.

Turbidity within the water column of Flathead Lake, caused by lakeward transport of shoreline soils eroded by wave action during storm periods, has been documented (Lorang and Stanford 1988) and reflects deteriorating water quality as a direct consequence of lake level regulation. Indeed, the shoreline is being eroded at an annual rate that varies from a few cm in protected bays and rocky areas to 3 - 5 m (1 m = 3.28 ft) on shorelines with soil profiles exposed to wave impact (e.g. the Bigfork side of the north shore, Hauer et al. 1988). Soils transported into the lake by the erosion process, like soils transported by river floodwaters, contain elevated nutrient concentrations. This source of nutrients is insignificant in terms of the lakewide nutrient budgets (Lorang and Stanford 1988), but probably explains in part why previous studies (Stanford et al. 1983) showed greater phytoplankton productivity nearshore than at midlake. Wave-caused erosion is not a problem in the natural lakes of the basin, as they have had hundreds of years to equilibrate with the annual variation in the hydrograph.

Chemical Constituents of Selected Streams and Lakes

If lakes and streams selected for long-term monitoring of chemical variables are indicative of the basin waters as a whole, and a myriad of monitoring data from other basin waters suggest they are (Stanford unpubl., Zackheim and Cooper 1983), water quality in the basin is in general very good (Tables 2 and 3). This is of course no surprise, since the majority of waters descend from Glacier National Park and various wilderness areas. Indeed, Gyrfalcon and McDonald Lakes and Dutch Creek are on par with the world's cleanest waters (Stanford and Prescott 1988) and the other sites are way above the national norm. However, Ashley Creek is obviously an exception (Table 2), largely as a consequence of the point source nutrient loads and other debilitating pollutants (e.g. toxic ammonia and oxygen-consuming organics) it receives from the Kalispell sewage treatment plant (see Dutton 1987).

A subtle water quality concern is reflected in these data (Tables 2 and 3), however. Note that the North Fork of the Flathead River at the Canadian border and Cabin Creek have higher SRP and lower nitrate concentrations than elsewhere in the basin (except, of course, in Ashley Creek). Correspondingly, the ratio of phosphorus to nitrogen (P:N) is higher. Obviously there are

Table 2. Mean conductivity (umhos/cm), nutrient concentration (ug/l) and ratio of total phosphorus to total nitrogen for selected lakes of the Flathead River Basin shown in Figure 1. Ranges are given in parentheses.

Site	Cond	SRP	SP	NO_3-N	NH_3-N	P:N	n (yr)
Gyrfalcon	30.3 (19-42)	<1 (<1-<1)	1.6 (<1-2.7)	23.4 (<10-85)	<5 (<5-13)	1:28	14 (6)
McDonald	95 (74-117)	<1 (<1-<1)	<1 (<1-<1)	152.0 (128-164)	<5 (<5-<5)	1:103	8 (4)
Whitefish	151 (138-164)	<1 (<1-<1)	3.7 (2.6-4.2)	20.8 (20-60)	5.1 (<5-6)	1:17	60(2)
Flathead	166 (156-177)	<1 (0.1-1)	4.5 (2-20)	38.4 (5-136)	5.6 (<5-12)	1:17	564(10)

Table 3. Mean conductivity (umhos/cm), nutrient concentration (ug/l) and ratio of total phosphorus to total nitrogen for selected streams of the Flathead River Basin shown in Figure 1. Ranges are given in parentheses.

Site	Cond	SRP	SP	NO_3-N	NH_3-N	P:N	n (yr)
Dutch	20 (10-35)	<1 (<1-<1)	4.0 (<1-5.5)	122 (32-300)	<5 (<5-<5)	1:>100	5 (3)
Cabin	198 (169-266)	10.6 (5-16)	12.8 (9-20)	15.3 (10- 44)	5 (<5-5)	1:<2	15(2)
North FK Border	213 (158-258)	1.8 (<1-7.9)	4.8 (<1-14)	17.2 (2-68)	6.8 (<5-32)	1:<4	106(5)
Flathead Holt	171 (141-189)	1.5 (<1-7.6)	6.2 (<1-11.0)	65.3 (10-142)	8.9 (<5-48)	1:10	127(10)
Ashley	362 (249-498)	452.3 (3-1970)	440.1 (17-2005)	860.0 (33-2641)	435.0 (18-1918)	1:6	55(4)

sources of phosphorus in the geology upstream of the Canada-U.S. border that do not exist generally in the basin and nitrate is proportionately scarce by comparison to other waters in the basin. This phosphorus-loading effect is diluted by phosphorus-poor waters downstream of the border that are largely derived from Glacier National Park; and, nitrate values increase downstream from the border. These data suggest that North Fork waters in Canada may be nitrogen limited in terms of their ability to produce plant biomass; whereas, waters downstream become progressively more phosphorus limited. Recent bioassay data (C. N. Spencer, Flathead Lake Biological Station, University of Montana, unpubl.) suggest that phytoplankton productivity in Flathead Lake may be limited by both nitrogen and phosphorus (see below). This is of extreme importance because one obvious impact of the proposed Cabin Creek coal mine will be that nitrogen concentrations will increase several orders of magnitude in waters draining the mine site (Mine Development Committee 1986). Blasting compounds used in the mining process would be the culprit. Since the exact concentrations that may eventuate are not known and no predictive models exist, one can only guess how far downstream the impact of increasing nitrogen fertility may extend. One study concluded that the effects on Flathead Lake would be minimal (Limnology Task Force 1986). However, it was concluded that water quality in the North Fork would be degraded by excessive growths of periphyton, which will accumulate in response to the predicted increases in nutrients caused by mining (Biological Resources Committee 1987). Since the waters in question are part of the Glacier - Waterton Parks International Biosphere Reserve, such an impact on water quality should be subjected to careful, quantitative study.

Another controversy in the Flathead Basin concerns the real or inferred relationship between deforestation by logging and road building and sedimentation in the creeks and rivers. Many studies in other forested catchments in the U.S. and elsewhere have clearly shown that sediments eroded by overland flow from roads and log skid trails can impair water quality by increasing turbidity and nutrient loads and by smothering benthic biota and young fish. Indeed, simulation models, based on predicted water yields in the Flathead as a result of deforestation, suggest that the extent of logging and related activities, particularly road building on steep, unstable slopes, should be expected to yield abnormal sediment loads in many of the streams in the basin (Enk et al. 1985, Zackheim and Cooper 1983). However, empirical evidence for such a relationship in the Flathead is sorely limited, especially as related to the cumulative effects of all aspects of forest development in the Basin.

Concentration of suspended sediment was positively correlated with discharge at all the mainstem river sites not influenced by dams (cf. Knapton 1978, Water Quality and Quantity Committee 1987, R. Appleman et al., Montana Bureau of Mines and Geology, unpubl. data). Annual sediment yields at these sites were also positively correlated with annual discharge, although the relation is weaker. Annual sediment yields have been determined at a number of Master Plan sites on smaller tributary creeks. Wide variation in yields by year and between catchments was observed, even in unroaded catchments (Table 4). Natural mass-wasting processes in the Krause Creek watershed seem to account for the very high sediment loads in that small catchment, which is not roaded upstream of the monitoring site. Annual sediment loads also vary in the Swift Creek catchment, upstream from Whitefish Lake (discussed below). But, in general, it is apparent that the smaller streams carry a much lower sediment load relative to the larger tributaries.

Most of the sediments entering Flathead streams apparently are derived from streambank erosion, rather than via overland flow . Most of this streambank erosion apparently occurs in the downstream reaches of major tributary and mainstem river segments (i.e. fourth order and larger) (Schultz 1987, Stanford unpubl. data). Krause Creek is a notable exception (Table 4), but even in Krause Creek the source of sediments seems to be mass-wasting of streambanks. Indeed, headcuts on the North Fork of the Flathead River have eroded in the last few decades to the extent that volume estimates can be made from sequential aerial photos (J. Ruth, Montana State University, unpubl. data). Since streambank erosion rates and, thus, sediment and associated nutrient concentrations are related to discharge, the question of major importance is whether deforestation abnormally increases discharge. Literature from other areas shows such a relationship (cf. Megahan 1983, Troendle and King 1987). But, research to date has not adequately addressed this issue in the Flathead.

The Master Plan calls for monitoring of sediment concentrations in the river bottom of key salmonid spawning streams in the basin. For example, gravel beds important to spawning bull trout in Coal Creek on the North Fork of the Flathead River contained slightly greater amounts of fine sediment than did other North Fork creeks (Fig. 3). The presence of fine sediments apparently reduces hatching success of bull trout spawn; only 44 percent survival is expected in Coal Creek gravels, where 35 percent of the bottom substrata is composed of materials <0.6 mm (1/4 inch) (Weaver and Fraley 1988). Long-term monitoring of gravel conditions in these key bull trout creeks, coupled with observations in pristine catchments and quantitative determination of sediment sources and volumes, will be required to verify trends in spawning gravel conditions relative to forest practices.

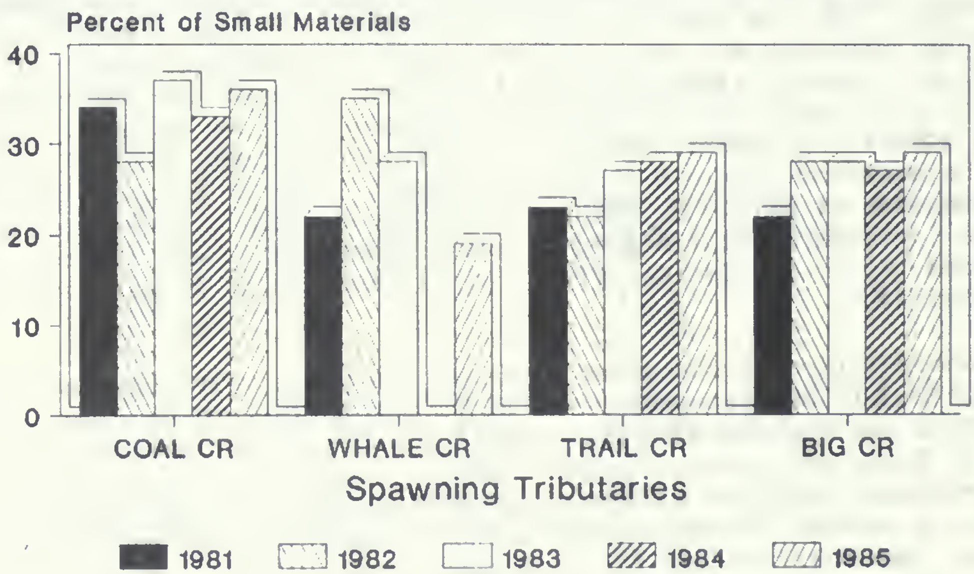

Figure 3. Percent of bottom substrata composed of materials <0.6 mm (1/4 inch) in size for tributaries of the North Fork of the Flathead River. Data are means of multiple samples taken on each creek at FBC monitoring sites each year for the period 1981 - 1985 (from Vashro 1987).

Table 4. Annual yield of suspended sediment (TSS) per unit area of selected catchments that are tributaries in the Flathead system. R refers to catchments that are partially logged and roaded; U refers to pristine areas (derived from Page 1987).

Site			Annual Yield (TSS) tons/mi^2/yr	
			mean	range
FBC01012	Lower Whale Creek	R	21.8	6.9 - 34.8
FBC01014	Coal Creek, North Fork	R	11.5	8.3 - 16.0
FBC01015	Coal Creek, South Fork	R	12.8	10.8 - 15.7
FBC01016	Coal Creek @ Deadhorse Bridge	R	32.2	9.2 - 79.8
FBC01017	Big Creek @ Lookout Bridge	R	199.8	- 199.8
FBC03006	Challenge Creek	R	2.0	0.4 - 3.6
FBC02002	Upper Whitcomb Creek	R	24.4	3.3 - 117.3
FBC02003	Lower Whitcomb Creek	R	7.5	1.0 - 15.3
FBC02004	Whitcomb Creek, West Fork	R	79.4	1.2 - 235.0
FBC02008	Sullivan Creek	R	14.3	1.4 - 43.1
FBC03007	Upper Wounded Buck Creek	R	16.2	7.0 - 22.4
FBC04002	Gregg Creek	U	3.3	1.5 - 5.1
FBC04004	Hand Creek @ Flume	U	0.7	0.6 - 1.0
FBC04005	Squaw Meadow Creek	U	2.0	0.7 - 5.0
FBC04006	Trib. of Squaw Meadow Creek	U	1.2	0.5 - 2.3
FBC04009	Fitzsimmons	R	11.0	3.2 - 42.9
FBC04010	Chepat	U	8.8	2.8 - 7.9
FBC04012	West Fork Swift	R	15.2	5.6 - 25.2
FBC04013	East Fork Swift	R	14.0	5.9 - 19.8
FBC04014	Chicken	U	4.2	1.4 - 5.7
FBC04015	Swift @ Conc. Bridge	R	23.9	17.9 - 33.6
FBC04016	Swift @ Crains	R	147.1	13.1 - 695.6
FBC06006	Krause Creek	U	670.0	138.0 - 1975.0

Hydrochemical Dynamics of Streams in the Stillwater State Forest in Relation to Water Quality in Whitefish Lake

Monitoring of water quality in the Swift Creek catchment upstream from Whitefish Lake has been important because of concerns about eutrophication in Whitefish Lake (Golnar and Stanford 1984) and because Swift Creek drains a large part of the Stillwater State Forest (SSF), one of the larger contiguous areas of forest managed by the State within the Flathead Basin.

Hydrographs typical of the Flathead in general were recorded at a site near the confluence of Swift Creek and Whitefish Lake (Swift Creek at Crains) and five other sites located upstream and elsewhere in the SSF (Fig. 4).

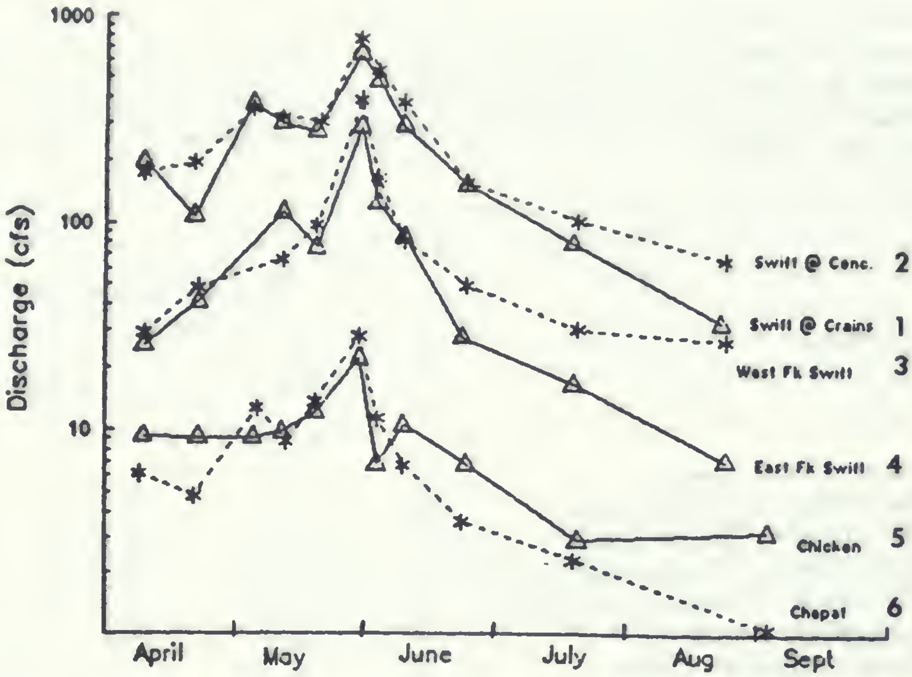

Figure 4. Stream hydrographs within the Stillwater State Forest in 1986. Sites 1 and 2 were located about 0.5 and 10 km respectively upstream from Whitefish Lake on the mainstem of Swift Creek; Sites 3, 4 and 5 were on tributaries of Swift Creek, except 6, Chepat Creek. It is a headwater tributary of the Stillwater River. Sites 5 and 6 monitored undeveloped subbasins, whereas the others are roaded and include logged areas (modified from Schultz 1987).

These flows produced suspended solids loads that were substantially higher in the downstream reach (i.e. Swift at Crains, Fig. 5), due to erosion of the streambanks in this lower reach. Similar situations occurred throughout the Flathead Basin, especially on fourth, fifth and sixth order stream segments (discussed above). Over 80 percent of the average annual suspended solids discharged by Swift Creek during 1976 - 1986 were derived from streambank erosion in the mainstem creek 10 - 15 km (1 km = 0.62 mi) upstream of Whitefish Lake. Suspended solids concentrations were positively correlated with discharge in Swift Creek; and, since the soils eroded from these streambanks contained an average of 318 ug-P/g solids (Ellis and Stanford unpubl.), total phosphorus concentrations were also positively correlated with suspended solids, as has been observed elsewhere in the basin (Stanford et al. 1983). Annual unit area phosphorus loads were lower at the upstream sites; whereas, the higher concentrations of sediment-phosphorus elevated the total phosphorus loads reaching Whitefish Lake (i.e. Swift at Site 1, Fig. 6). Nitrate-nitrogen values were not correlated with discharge or suspended solids concentrations in the Swift Creek catchment for the period of record. The maximum nitrate concentration recorded in the catchment was 0.21 mg/l, and most values were lower by at least a factor of 10.

Nutrient loads received annually by Whitefish Lake are predominately derived from Swift Creek. Most of the nitrogen and phosphorus reaching Whitefish Lake is associated with spring runoff, when Swift Creek is laden with suspended sediments. Production of algae in the lake appears to be phosphorus limited (Golnar 1985, Golnar and Stanford 1984) and, although it is unlikely that >10 percent of phosphorus associated with spring runoff is bioavailable (cf. Ellis and Stanford 1988), Swift Creek clearly fertilizes the lake (Golnar and Stanford 1984). How much of the annual nutrient load in Swift Creek is related to logging and road building in the catchment is unclear from the data gathered to date. Analysis of covariance for suspended solids as a function of unit area flows did not clearly show trends that could be separated significantly from natural variability at all sites, given the number of samples taken to date. Moreover, the lowest mean annual sediment yield of all sites in the Swift Creek catchment was recorded at Chicken Creek (Fig. 5), which is largely undisturbed by logging; yet, total phosphorus loads were higher in Chicken Creek than in the West Fork of Swift Creek (Fig. 6), which has had considerable harvest and roading activity.

While the monitoring data collected to date did not show that forest management activities have impaired water quality in Swift Creek or Whitefish Lake, it is not likely that the many miles of road and acres of harvest within the Stillwater State Forest have been completed without associated cumulative impacts. More intensive monitoring may be needed to establish a true relationship, if one indeed exists, between water quality variables and forest practices in the Swift Creek catchment.

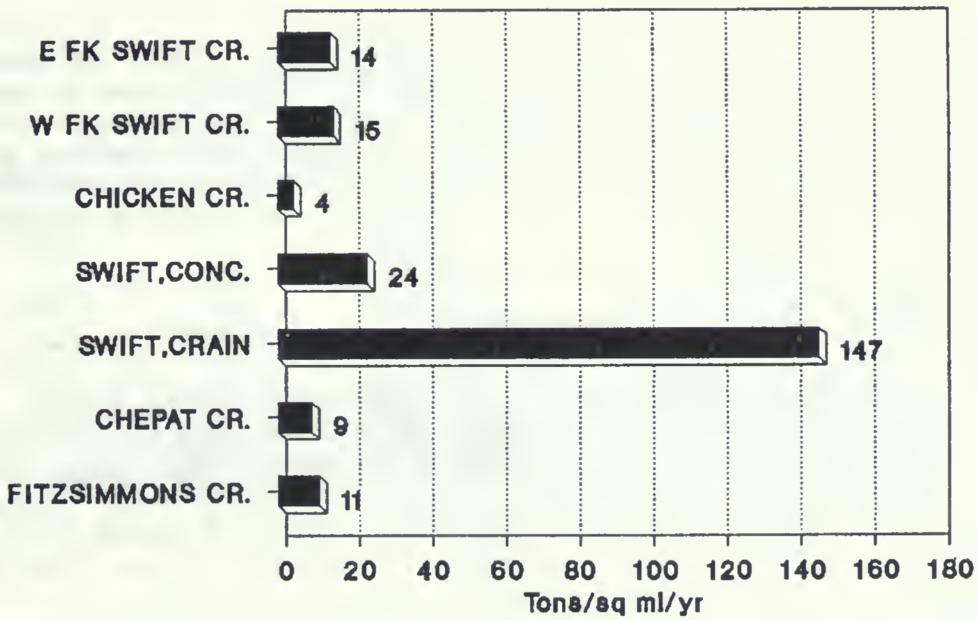

Figure 5. Unit area suspended sediment yield (tons/mi^2/yr) for catchments in the Stillwater State Forest. Data are means for the period 1976 - 1986. Sites as in Fig. 4, except for the addition of Fitzsimmons Creek, another headwater tributary of the Stillwater River (from Schultz 1987). Note that the data are expressed in U.S. tons (1 ton = 2,000 lbs = 907 kgm).

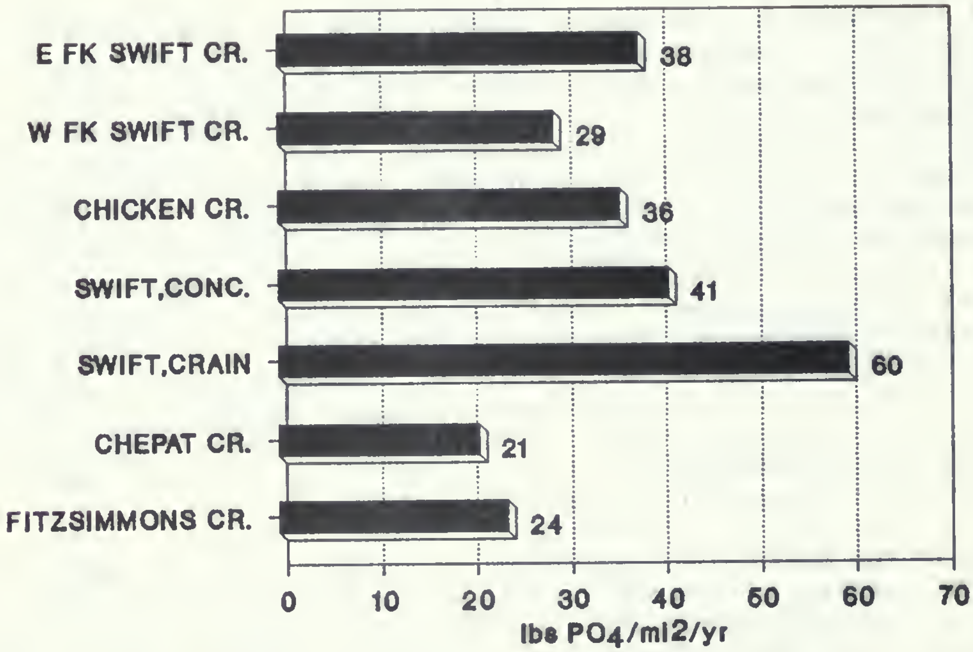

Figure 6. Annual yields of total phosphorus (lbs-PO_4/mi^2/yr) for catchments in the Stillwater State Forest. Data are means for the period 1982 - 1986. Data are pounds of phosphate per square mile per year (1 lb = 0.454 kgm); sites are as in Figs. 4 and 5 (from Schultz 1987).

The same is true elsewhere in the Flathead River Basin and pertains to all land uses and owners. However, monitoring objectives must be evaluated carefully before initiating more intensive sediment monitoring on streams in the Basin. In some instances it may be more productive to examine more extensive integrative measures, such as changes in stream channel morphology (using time-series aerial photos) or the historical records in sediment cores from lakes in the Basin.

Annual Dynamics of Bull Trout Redds in Flathead River Basin Streams

Redd (spawning bed) counts are thought to reflect the general strength of the annual spawning migration from Flathead and Swan Lakes into key spawning streams identified in the Flathead River Basin Environmental Impact Study (Zackheim and Cooper 1983). Numbers of bull trout redds in the Middle and North Fork tributaries have been annually enumerated since 1979; tributaries in the Swan catchment have been counted each year since 1982.

Redd counts on selected tributaries averaged about 360 for the period of record on tributaries of the North and Middle Forks of the Flathead River. Numbers of redds peaked in 1982 (Fig. 7), corresponding to a strong year class apparently derived from ideal spawning and rearing conditions that existed in 1975 - 76. Counts were generally low in the entire Flathead drainage in 1985 due to extremely low summer flows which may have impeded fish migration and subsequent record high flows in the fall obscuring many redds during the count. In 1986 redd counts were slightly above average, with numbers down 16

percent in the North Fork (Fig. 8) but up 17 percent in the Middle Fork (Fig. 9). In particular, reduced numbers occurred on Coal Creek in the North Fork (down 70 percent), while the greatest increase (75 percent) was observed on Lodgepole Creek in the Middle Fork.

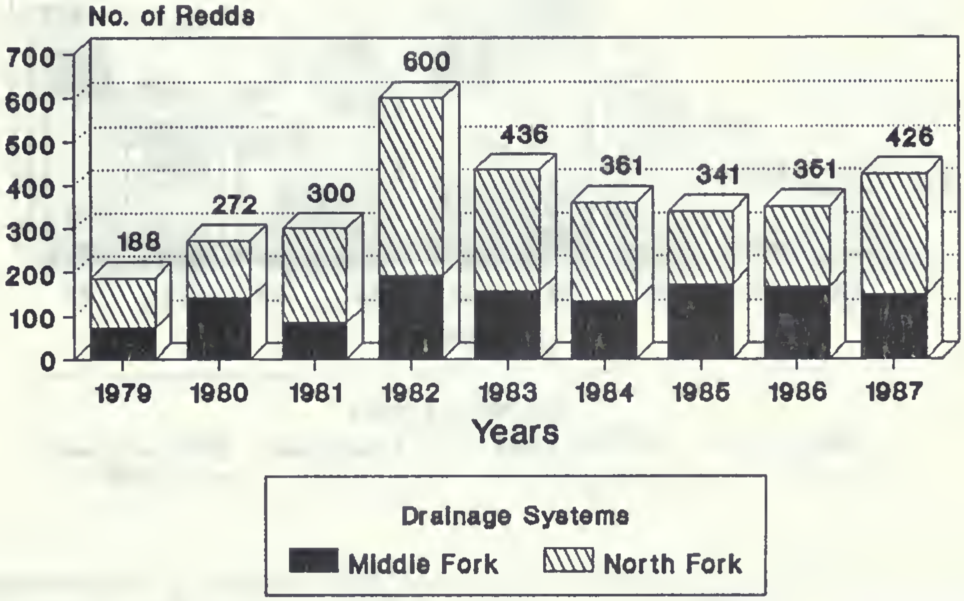

Figure 7. Bull trout redd counts for North and Middle Forks of the Flathead River Drainage, 1979 - 1987 (modified from Vashro 1987).

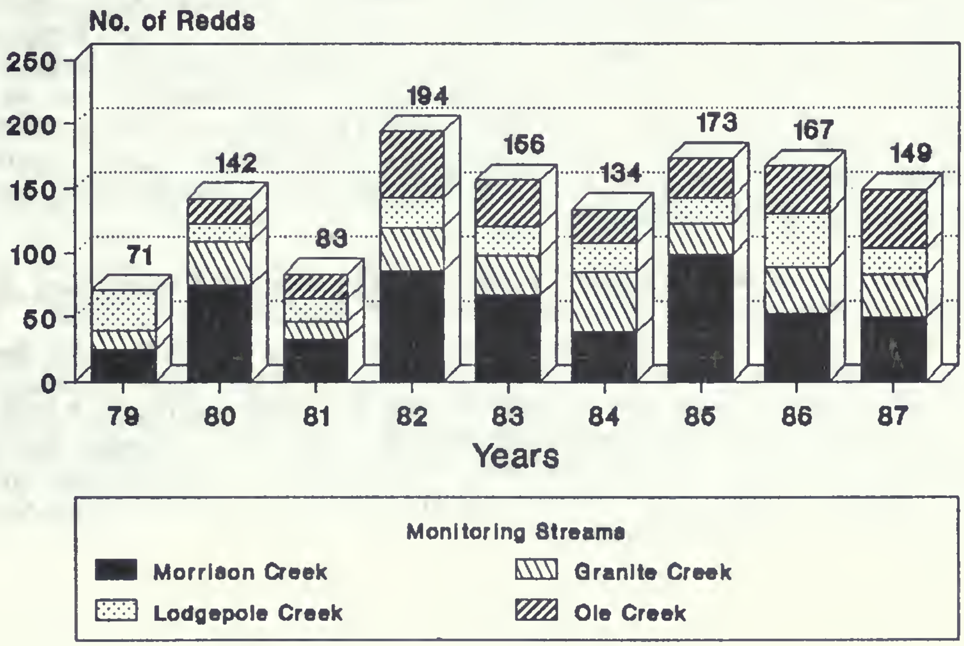

Figure 8. Bull trout redd counts for monitored reaches of tributaries of the Middle Fork of the Flathead River, 1979 - 1987 (modified from Vashro 1987).

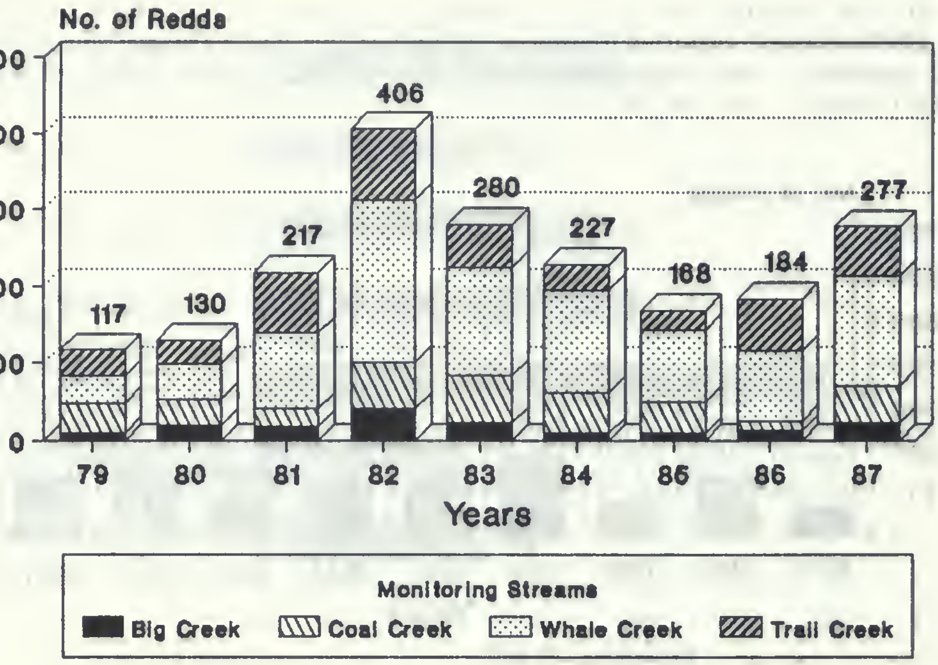

Figure 9. Bull trout redd counts for monitored reaches of tributaries of the North Fork of the Flathead River, 1979 - 1987 (modified from Vashro 1987).

Bull trout averaged 3.2 fish per redd over the period of record. Therefore, the 1986 count represented 1,235 fish spawning in the monitored reaches. The total spawning population, based on drainage-wide redd counts in 1980, 1981, and 1982, averaged 3,400 bull trout per year. If 30-50 percent of the spawning run is lost to angler harvest or other mortality before spawning (MDFWP unpubl. data), the total spawning run (i.e. number of fish migrating upstream from Flathead Lake) was 6,000-7,000 fish during 1980 - 1982. On the basis of all data available, including creel data (MDFWP unpubl. data), it appears that the bull trout population derived from Flathead Lake is stable and in relatively good condition.

The Swan River was originally part of the Flathead migratory system. The Swan River was blocked by construction of Bigfork Dam in 1902. A fish ladder on the dam provides only marginal fish passage. Thus, the Swan catchment now has its own spawning populations of bull trout. The 1986 redd count of 210 (Fig. 10) was very close to the 5-6 year average of 208 redds. Based on redd counts in all tributary streams, the four streams routinely monitored (Fig. 10) provide 90 percent of the bull trout spawning in the Swan drainage. These streams were closed to all fishing in 1984 to maintain the Swan Lake bull trout population.

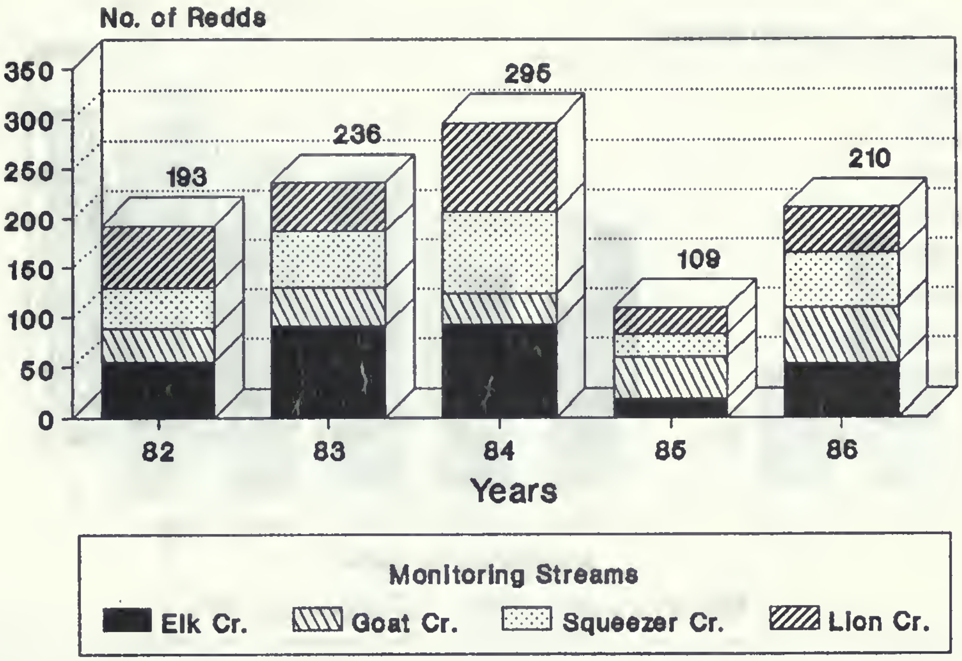

Figure 10. Bull trout redd counts on monitored tributaries in the Swan Drainage, 1982 - 1986 (from Vashro 1987).

Density of Juvenile Bull Trout in Coal and Morrison Creeks

Populations of juvenile bull trout have been monitored in selected tributaries (Fig. 11): Coal Creek in the North Fork and Morrison Creek in the Middle Fork of the Flathead River.

The numbers of juvenile bull trout seem to follow trends in the redd counts, suggesting that year class strength is reflected by trends in number of spawning adults during the previous two to three years. It therefore appears that Coal Creek could produce more young bull trout if egg/embryo survival improved or if more adult fish returned to spawn. Nevertheless, Coal Creek continues to support relatively high densities of juvenile bull trout.

The population of juvenile bull trout in Morrison Creek has been fairly stable over the last seven years. During the same period no additional development has occurred in this drainage. One significant decline in juvenile abundance was observed in 1983 but populations returned to previous levels by 1985.

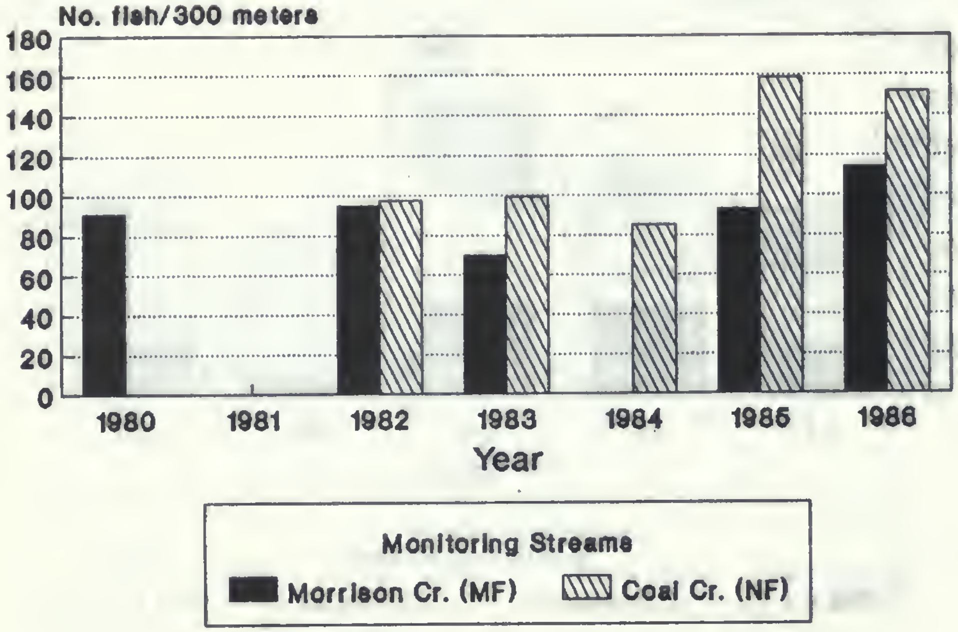

Figure 11. Juvenile bull trout densities in Coal Creek (North Fork drainage) and Morrison Creek (Middle Fork drainage), 1980-1986 (from Vashro 1987).

Densities of Westslope Cutthroat Trout in Basin Streams

Cutthroat trout populations have been monitored in Challenge Creek (Middle Fork tributary), Coal Creek (North Fork tributary) and other streams. Challenge Creek appears to be one of the more important juvenile rearing streams in the Flathead system. The Challenge Creek estimates ranged from 66 - 126 fish/100 yards (1 yd = 0.91 m) of stream channel.

In Coal Creek, cutthroat trout populations have remained at a fairly stable range (from 9 - 56 fish/100 yards of stream) but at a lower level over the last five years. An experimental planting of over 90,000 fingerling cutthroat in late 1982 increased 1983 densities but failed to have a lasting effect on the population.

Numbers of adult cutthroat trout in the Hungry Horse Creek, a major spawning stream for migrants from Hungry Horse Reservoir, have declined in recent years (Fig. 12). Other data and angler opinion suggest that runs in the South Fork drainage in general have declined in recent years (May and Weaver 1987). Therefore, restrictive angling regulations were placed on the river in 1984.

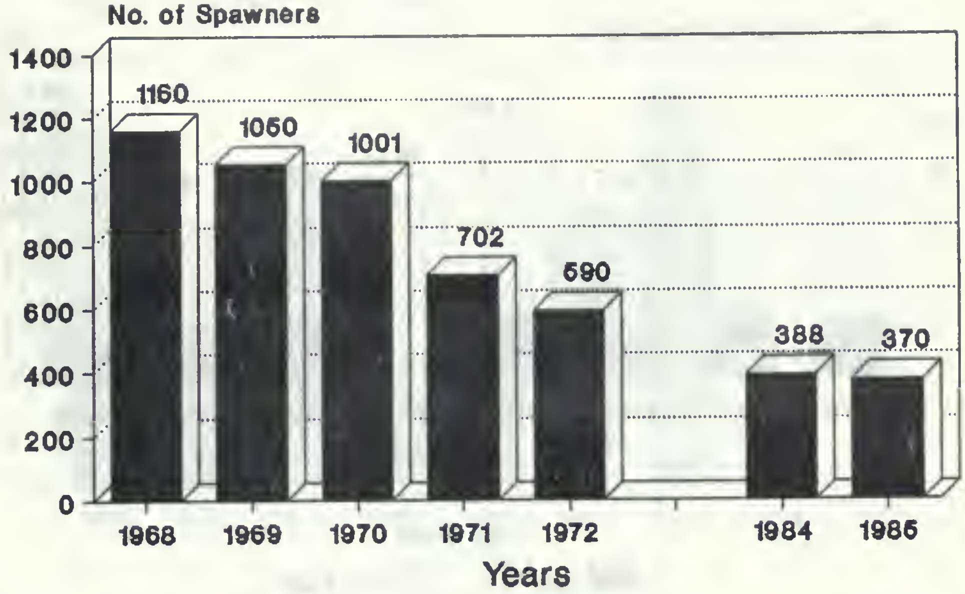

Figure 12. Numbers of westslope cutthroat trout spawners entering Hungry Horse Creek from Hungry Horse Reservoir (from Vashro 1987).

Population Dynamics of Kokanee Salmon in the Flathead System

Salmon populations in Flathead Lake are monitored with hydroacoustic equipment. More than 70 miles of transects are measured each fall to yield estimates of the density of salmon (Fig. 13). Densities are measured as "small" immature salmon (less than 10 inches) and "large" or adult salmon (longer than 10 inches) which will spawn that fall. Although there appears to be a weak relationship between densities of "small" fish one year and "large" fish the following year, harvest appears to have a profound effect on the number of small fish that ultimately survive to spawn. Density estimates during 1985 and 1986 were made without the concurrent sampling with a midwater trawl. Numbers of salmon during these years may be biased by inadvertent enumeration of fish other than salmon. This appears to have happened, since fair numbers of salmon were consistently recorded in the lake (Fig. 13), but the numbers of spawners reaching McDonald Creek declined dramatically in 1986 and 1987 (Fig. 14).

The numbers of kokanee spawners have fluctuated over the years (Fig. 14). Prior to 1975, many kokanee spawned in the main Flathead River and at specific sites (e.g. Yellow Bay) on the shores of Flathead Lake. However, fluctuations in the river due to releases from Hungry Horse Dam have dramatically reduced spawning success and subsequent spawning runs in recent years. Similarly, fluctuations in the levels of Flathead Lake for power production appear to be partially responsible for declines in lakeshore spawning. The Flathead lakeshore once produced up to half the spawning in the drainage but now is insignificant. McDonald Creek below McDonald Lake in Glacier National Park remains relatively free of habitat disturbance and now provides the majority of spawning in the Flathead system. Indeed, since 1985 essentially all of the spawning appears to have occurred only in McDonald Creek.

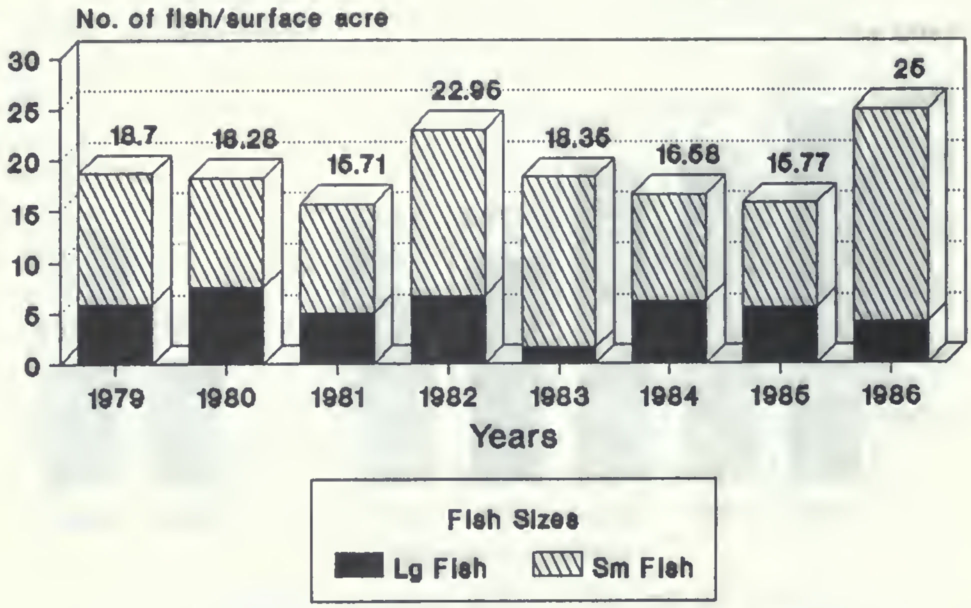

Figure 13. Fall acoustic estimates of kokanee, fish per surface acre, in Flathead Lake, 1979 - 1986 (from Vashro 1987).

The 1985 spawning run, primarily offspring of the strong 1981 spawning run, was the highest number of spawners since surveys began in 1979. Unfortunately, in the last two years (1986 and 1987) the numbers of spawners declined dramatically (Fig. 14). This was apparently due to a combination of factors, none of which were clearly documented. First, it appears that stream and lake regulation slowly reduced the river and lakeshore spawning populations to ineffective numbers. Second, angler harvest of the older year classes of kokanee may have reduced the numbers of spawners; since 1980 the percentage of the population made up of 4+ year old fish has steadily declined (Beattie and Clancy 1987), due to either overharvest or predation. Finally, the decline in numbers of kokanee in the last two years corresponds to the establishment of the opossum shrimp Mysis relicta in Flathead Lake (discussed below). Mysis are known to be detrimental to kokanee in lakes like Flathead (Lasenby et al. 1986). Agreements with the Bureau of Reclamation to provide minimum flow releases from Hungry Horse Dam may help the recovery of spawning populations in the main Flathead River, if effective numbers reach spawning age in Flathead Lake. Hatchery fry have also been introduced into the lake to augment residual, natural populations. Whether these efforts will be sufficient to resurrect this popular sport fish remains in question.

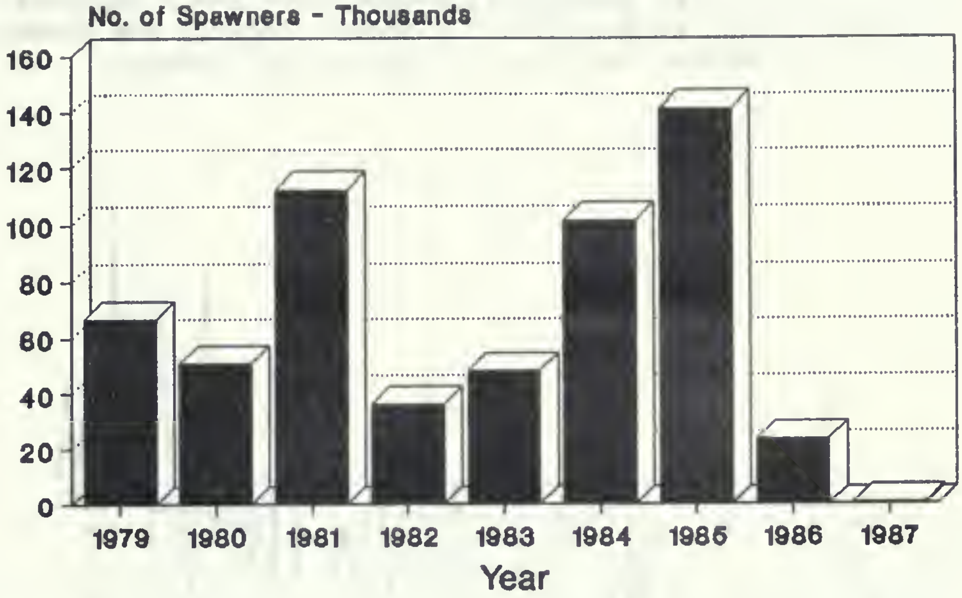

Figure 14. Number of kokanee spawners in the Flathead River Drainage, 1979 - 1987 (modified from Vashro 1987).

Biophysical Trends in Flathead Lake

The limnology of Flathead Lake has been under continuous study since 1977 and by 1983 it was concluded that the lake was showing early signs of eutrophication from nutrient pollution, mainly from urban sewage (Stanford et al. 1983, Zackheim and Cooper 1983). In response to these concerns, a management plan for limiting inputs of phosphorus to the lake was implemented (Water Quality Bureau 1984) and the lake has become a focal point for water intensive quality monitoring (FBC 1986). One reason for the monitoring effort was to determine if water quality in the lake is changing, especially in response to upgraded sewage treatment plants in the urban centers and increasing emphasis on "best management practices" for timber harvest and agriculture in the basin (see Bahls 1986, Water Quality Bureau 1984).

Of the many biophysical variables examined to date (e.g. nutrient concentrations, nutrient loading rates, temperature regimes, phytoplankton crops), most do not exhibit statistically significant trends; interannual variation is too large for trends to be apparent, in most cases. But, there were two notable exceptions.

First, secchi depth has increased over the period of record, 1977 - 1988 (Fig. 15). This suggests the water column contains less suspended solids. The data clearly show the reduction of water clarity during the overflow turbidity period in the spring (note the recurring minimum values in Fig. 15). Turbid waters occurred less frequently in the more recent half of the record, corresponding to the generally lower water yield from the drainage basin during spring runoff of those years (i.e. 1983 - 1987). Thus, these data may reflect drier years when the river system delivered lower amounts of suspended solids to the lake; these data do not necessarily mean that water clarity improved as a result of changes in the phytoplankton community. Indeed, the

phytoplankton data do not suggest any major changes, other than the lakewide bloom of the pollution alga Anabaena flos-aquae previously reported for the summer of 1983 (Stanford et al. 1983). Although Anabaena was present every summer in very low numbers, the bloom of 1983 did not reoccur.

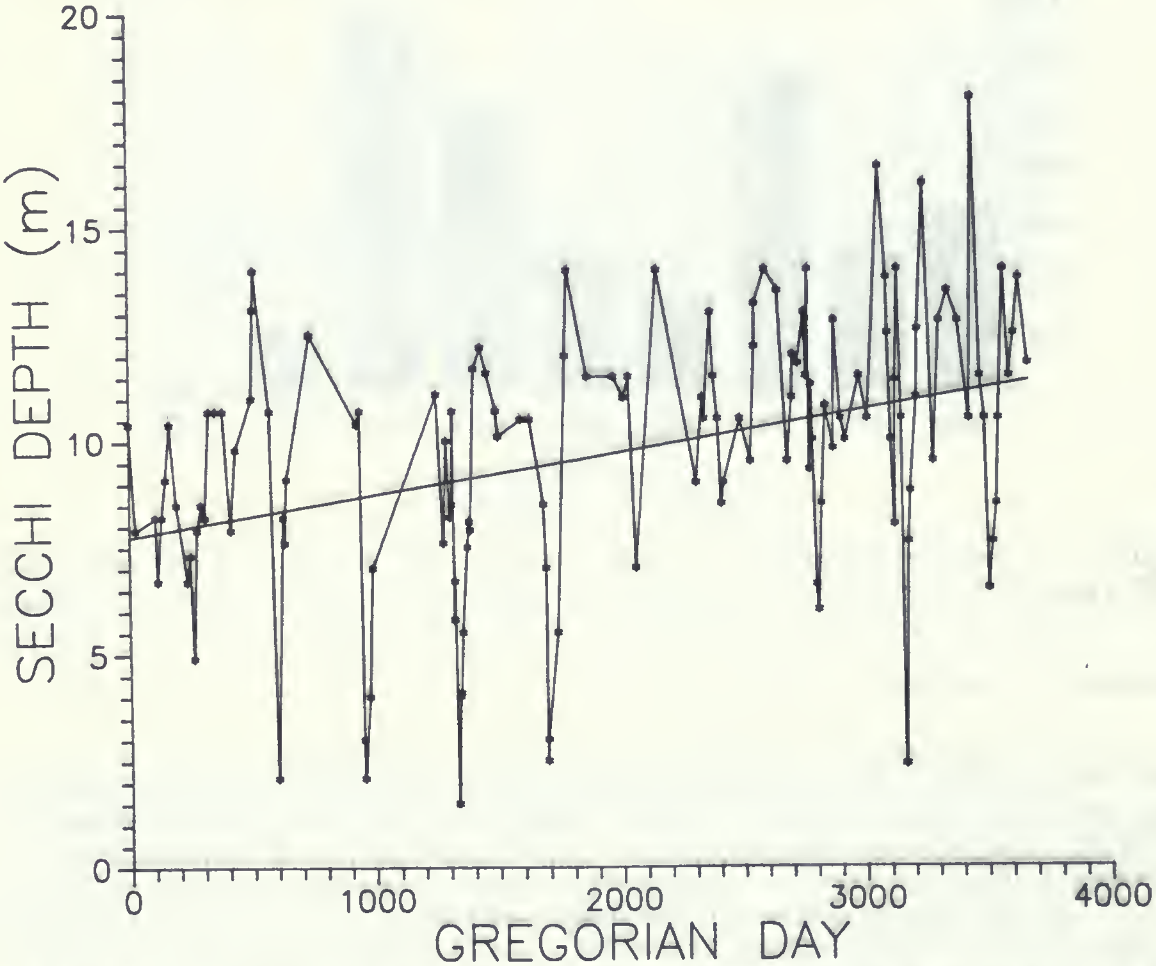

Figure 15. Secchi disk depth (m) from April 1978 through September 1987 at the midlake deep site in Flathead Lake. Linear regression of the data is indicated by the best fit line (from Stanford and Ellis 1988).

The second trend of importance was increasing phytoplankton primary production (Fig. 16). The trend is statistically significant only because of the 1987 value, the highest annual production measure for the period of record. Moreover, only 5 data points representing 5 annual productivity estimates (i.e. each datum summarizes a minimum of 12 monthly values) were available. This trend may also be related to the generally drier years late in the record, among other things (e.g. dynamics of discharges from Hungry Horse Reservoir, which may influence delivery of nutrients to the lake and, thus, also influence primary production). In any case, the trend is not steep; the change during the period of record amounted to about 6 percent.

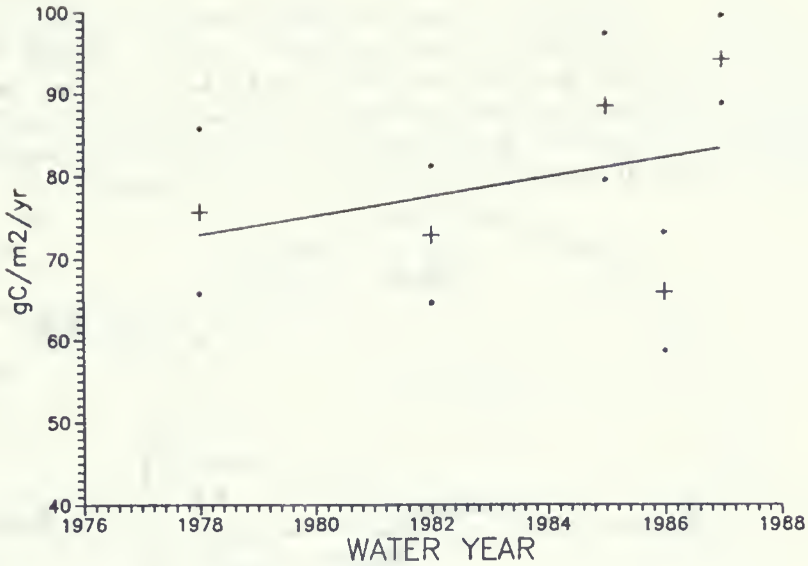

Figure 16. Annual primary production estimates (gC/m^2/yr) determined from biweekly to monthly duplicate water column profiles (0-30 m) at the midlake site in Flathead Lake. The mean of the minimum and maximum estimates is indicated by the cross and a linear regression of the data is represented by the best fit line (from Stanford and Ellis 1988).

One cannot draw major conclusions from these trends. But, water quality in the lake seems to remain on a nutrient threshold as concluded by Stanford et al. 1983 (see also Bahls 1986); additional pollution from any source, coupled with the right limnological conditions in the lake (e.g. warm temperatures, extended periods of calm weather), could again stimulate lakewide bloom of Anabaena.

No evidence exists that nitrogen or phosphorus loading (i.e. elemental mass of N and P per unit volume of water reaching Flathead Lake) has increased significantly in the last half decade, nor do the data suggest that amounts reaching Flathead Lake from the catchment have decreased. Indeed, annual loading values for the period 1977 - 1987 did not deviate significantly ($P > 0.10$) from mean values for the period (Fig. 17). However, important progress has been made within the basin to reduce the loads from some of the sewage treatment plants (STPs). Several of the smaller urban areas (e.g. Bigfork, Lakeside) have upgraded STPs to allow nutrient removal, especially phosphorus. Moreover, the ban on sale of phosphorus-containing detergents in Lake and Flathead Counties seems to be effective (Fig. 18). But, in spite of lower phosphorus concentrations in sewage effluents from the Kalispell STP, owing to decreased detergent phosphorus (Fig. 18), Ashley Creek data do not indicate any improvement ($P > 0.01$) in the nutrient contamination problem illustrated in Table 2. This is probably because so much phosphorus is stored in the creek's sediments. The P ban is helping, but phosphorus concentrations in the effluent remain more than an order of magnitude higher than 1.0 mg/l, a limit that is routinely achievable in modern STPs. Clearly, the Kalispell STP needs to be rebuilt to include technology for reducing nutrient content of its effluent, for the benefit of water quality in Ashley Creek (see also Dutton 1987) and Flathead Lake.

Progress toward reaching an effective and basinwide nutrient control program (Bahls 1986, Water Quality Bureau 1984) is encouraging. If other sources of nutrients, particularly air pollution and sediments from nonpoint origins (e.g. wood burning and erosion associated with canopy removal and lake level manipulation), do not offset reductions in nutrient loads from the STPs, future data should demonstrate a decline in nutrients reaching Flathead Lake. The monitoring program of the FBC is vital in this regard.

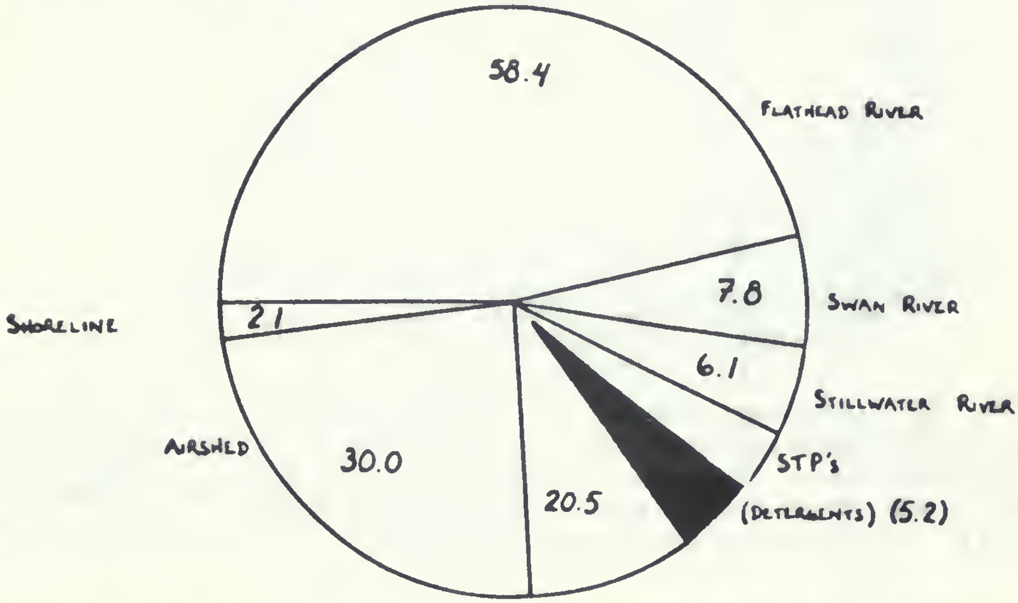

Figure 17. Annual input of biologically available phosphorus (metric tons) to Flathead Lake from the major tributaries, the airshed, sewage treatment plants, and shoreline erosion and septic systems (from Stanford and Ellis 1988).

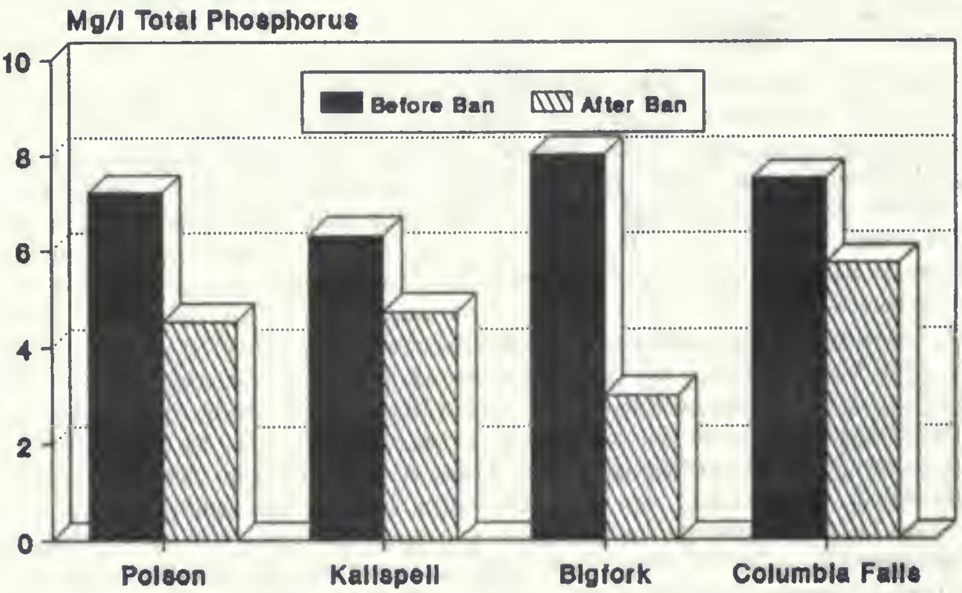

Figure 18. Average total phosphorus concentrations (mg/l) of influent sewage at the four largest treatment facilities within the Flathead Basin before (solid histograms) and after (hatched) the Flathead County phosphorus detergent ban was enacted.

Changes in the Food Web of Flathead Lake

During the period 1977 - 1987 the food web of Flathead Lake changed dramatically, owing primarily to the establishment of Mysis relicta. Prior to 1980 Mysis were not present and the zooplankton community was characterized by abundant, large cladocerans or water fleas (Potter 1978). These cladoceran zooplankton were the primary food items for the pelagic fishes of the lake, of which kokanee salmon (Oncorhynchus nerka) were particularly important. Between 1968 and 1975 Mysis were introduced into Whitefish and Swan Lakes from their native habitat in Waterton Lake on the Alberta - Montana border by the Montana Department of Fish, Wildlife and Parks in an effort to provide a better forage for lake trout (Salvelinus namaycush; see Bukantis and Bukantis 1987, Leathe and Graham 1982). Mysis apparently moved downstream to infest Flathead Lake and by 1983 were present in sufficient numbers to be quantified. The population expanded rapidly on an areal basis but has now begun to stabilize at about 100 individuals per m^2 (1 m^2 = 1.196 yd^2) (Fig. 19). Since Mysis is known as a voracious predator of water fleas (cf. Lasenby et al. 1986), it should not be surprising that the cladoceran fauna of Flathead Lake has been decimated (e.g. Fig. 20). Large, slow-swimming species, like Daphnia longiremis and Leptodora kindtii, have apparently been greatly reduced, if not extirpated. In Waterton and other lakes where Mysis is native, the zooplankton community is virtually devoid of Cladocera; other small and very mobile forms (e.g. Copepoda and Rotifera) dominate. The situation in Flathead Lake is rapidly becoming similar, although the only cladoceran remaining in any numbers, Daphnia thorata, seems to be able to maintain a viable population above the thermocline in midsummer (Fig. 21). Apparently Mysis prefer to feed in colder waters and do not pass through the thermocline in large numbers (C. N. Spencer, Flathead Lake Biological Station, University of Montana, personal communication).

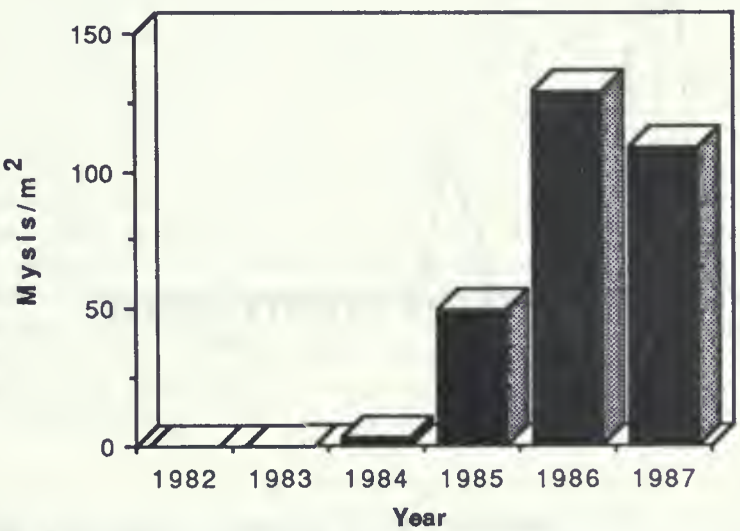

Figure 19. Density of Mysis relicta (organisms/m^2) in Flathead Lake. Data are annual mean values obtained from a lakewide census in the fall of each year (figure provided by C. N. Spencer, Flathead Lake Biological Station)

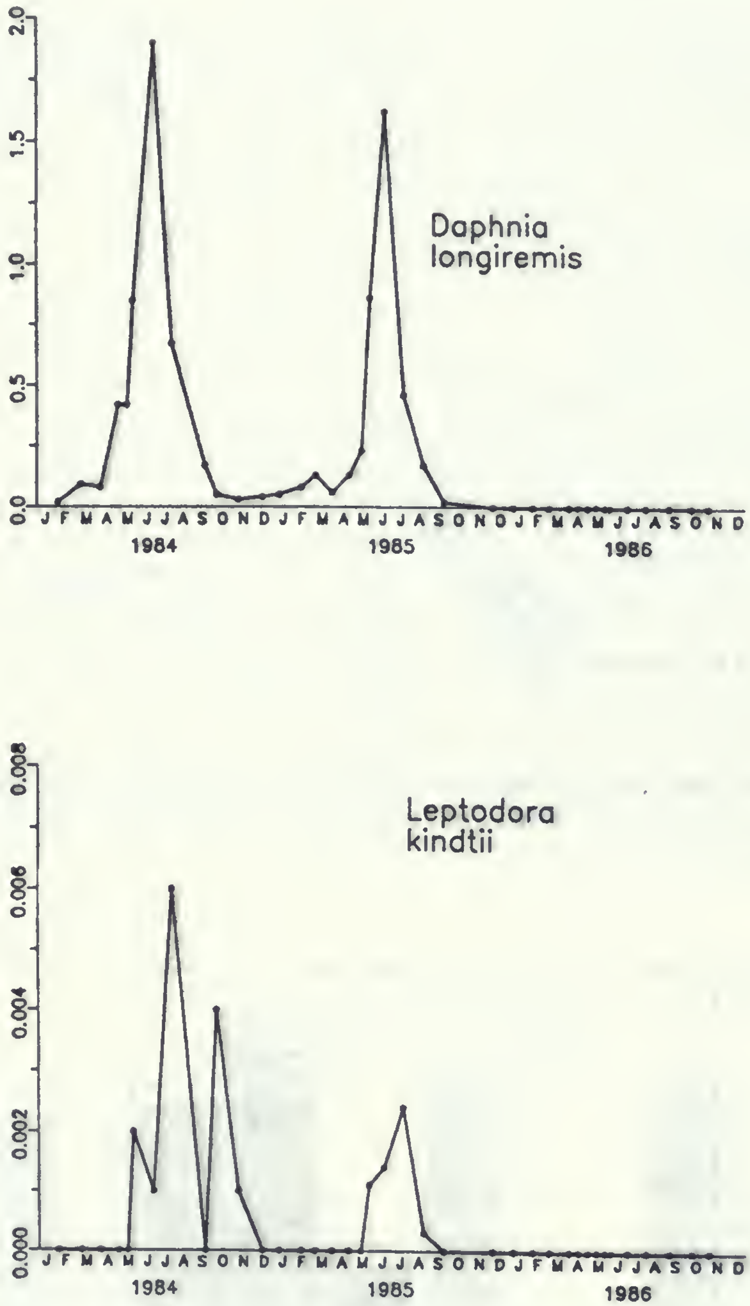

Figure 20. Mean densities (organisms/liter) of Daphnia longiremis and Leptodora kindtii at the midlake deep site in Flathead Lake, 1984 - 1986 (from Stanford and Ellis 1988).

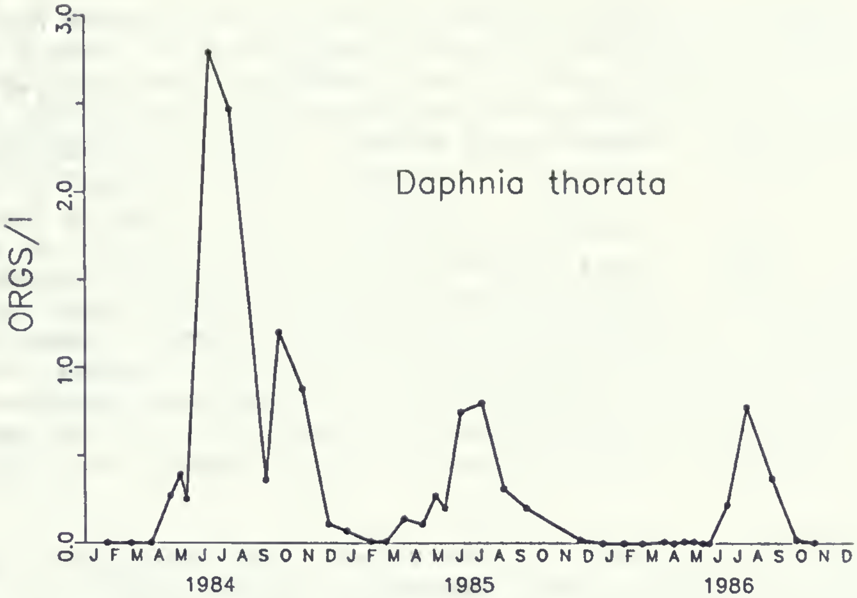

Figure 21. Mean density (organisms/liter) of Daphnia thorata at the midlake deep site in Flathead Lake, 1984 - 1986 (from Stanford and Ellis 1988).

Since the larger zooplankters in the lake have been greatly reduced, it may be inferred that the phytoplankton (algae) should be able to expand their populations owing to less grazing pressure. The presence of more algae in the water column should reduce water clarity; secchi disk readings, for example, should decrease (Kitchell and Carpenter 1987). This rationale is supported by data from Lake Michigan, although the cause - effect is opposite. The water column in Lake Michigan, which is very comparable to Flathead Lake in terms of nutrient content and primary productivity, became clearer (i.e secchi disk readings increased significantly) after introduced chinook salmon reduced the population size of alewife (Alosa pseudoharengus). The alewife had been a voracious predator on the larger zooplankton; when the predation pressure was removed by the salmon, the water column was grazed clear by the zooplankton (Scavia et al. 1986). However, secchi disk readings in Flathead Lake have increased (Fig. 15) and recent bioassay data suggest that the phytoplankton in Flathead Lake are controlled more by bioavailability of nitrogen and phosphorus than grazing pressure (C. N. Spencer, Flathead Lake Biological Station, University of Montana, personal communication). Regeneration of bioavailable nutrients is in part controlled by the zooplankton community (e.g. through excretion of labile forms of N and P) and the elimination of major portions of the community does have ecosystem-level ramifications on lakewide primary production. Careful research will be needed to determine the effects of the Mysis invasion on the smaller components of the food web.

The effect on fishes may be more straightforward. Fishes that can eat Mysis should do very well. For example, lake whitefish and lake trout were introduced into Flathead Lake from Canadian Shield lakes where they evolved with Mysis; they are natural predators of Mysis because, like Mysis, they prefer to reside deep in the water column, rising out of the depths only during the colder months to feed. Mysis feeds on zooplankton within the water column at night and rests on the bottom diurnally; therefore, Mysis is essentially unavailable as forage for pelagic fishes. Surface-dwelling

fishes, like kokanee, that depend on the same food resources as _Mysis_ may starve. Indeed, 1987 spawning runs of kokanee from Flathead Lake were at an all-time low (Fig. 14) since they were introduced into the lake over 50 years ago. As discussed above, other factors than _Mysis_ were involved in the kokanee decline, particularly lake and stream regulation by the dams (which dewatered redds) and overharvest by anglers. However, the presence of _Mysis_ seriously compromises recovery of the kokanee fishery, based on experience elsewhere (Lasenby et al. 1986). The effect of the changing food web on other fishes, of particular interest are bull and cutthroat trout, is uncertain. However, bull trout at least live fairly deep in the water column and may benefit from presence of _Mysis_ as food. But, bull trout and lake trout are largely piscivores and have preferred kokanee as forage (Leathe and Graham 1982); one _Mysis_ does not a kokanee make in terms of calories. Unless some other forage fish (perhaps pygmy whitefish) becomes more abundant by taking advantage of the rich _Mysis_ food base, piscivores such as bull and lake trout may be food limited in the future and not reach trophy size as they have in the past.

In terms of water quality, the changing food web must be viewed as a negative impact. Clearly, the mechanisms of energy and nutrient transfer have been altered in Flathead Lake. However, the food web will stabilize over time, unless some new exotic is introduced. The leveling of the population growth curve of _Mysis_ (Fig. 19) suggests a return toward equilibrium conditions is already occurring. In time and with proper monitoring the long-range implications of the food web alteration will become apparent.

CONCLUSIONS: INTERACTIVE THREATS TO WATER QUALITY IN THE FLATHEAD BASIN

"Water quality" means different things to different people. In a regulatory sense, water quality encompasses 1) the natural characteristics of water (i.e. ambient concentrations of dissolved and particulate constituents), 2) the temporal variation of those characteristics and 3) degradation of those characteristics to the extent that use of water by humans is impaired. However, to citizens of the Flathead, water quality seems to refer to just about any aspect of water or its biota that influences the esthetic or economic quality of human experiences in relation to the lakes and streams of the basin (e.g. see Lenihan and Johnson 1987). Most people recognize the important relationship between water quality and activities that alter landscapes (e.g. dams, deforestation, urbanization) or ecological processes (e.g. fish migrations, insect and plant distributions) within the basin, especially when landscape modifications are made without an attempt to minimize impacts on water quality. Indeed, the Flathead River Basin may best be referred to as an ecosystem in which terrestrial, atmospheric and aquatic components and processes are dynamically linked (Stanford and Potter 1976, Zackheim and Cooper 1983). Thus, _anything_ that quantitatively changes ecosystem integrity (i.e. structure and function) may be deemed a threat to water quality.

The status of water quality in the Flathead Basin in general appears to remain very high. Many of the basin's waters are on par with the world's cleanest waters and are free of measurable contaminants. The basin's salmonid sport fisheries (e.g. bull and cutthroat trouts) are especially dependent on clean, cold water and their spawning and rearing habitats are vulnerable to even slight changes in system water quality. The presence of self-sustaining

populations of these fishes in the basin is an important indication of the purity of the water. Indeed, sport fishing in the pristine waters of the Flathead Basin provides over 200,000 days of recreation each year and generates millions of dollars of revenue to the local economies. Clean rivers and lakes and days spent afield fishing are an integral part of the quality of life for residents and visitors to the Flathead.

However, some water quality problems have been quantified by the monitoring process and appear to threaten aquatic resources. The most pressing problems involve 1) regulation of water flow by Kerr and Hungry Horse Dams, 2) abnormal nutrient (N and P) loading, especially from Ashley Creek and 3) alterations of the food web in Flathead Lake by *Mysis*. In recent years a much greater understanding of problems associated with water regulation has been forthcoming. Processes are evolving to alleviate or mitigate the negative impacts of stream and lake regulation (e.g. Fraley 1986). Sources of nutrient pollution have been curtailed significantly by upgrading of sewage disposal facilities, the phosphorus detergent ban and enhanced public awareness. However, Kalispell sewage, including groundwater pollution of the Evergreen area, remains a serious problem. The proposed Cabin Creek coal mine, if developed, could become another serious water quality problem. Indeed, the Board Report of the International Joint Commission reference on potential mine impacts concluded that the North Fork of the Flathead River, which is an important part of the Glacier - Waterton International Biosphere Reserve, would be polluted by sediments and nutrients and up to 10 percent of the basin's bull trout would be lost if the mine were developed (Study Board 1988). The introduction of *Mysis* into the Flathead Basin cannot be reversed; the opossum shrimp has changed the food web of Flathead Lake forever. However, the food web will adjust in time and it is likely that certain fishes (e.g. lake whitefish) may expand their populations in the process.

Other potential water quality problems are being addressed by the FBC through the monitoring process. For example, the cumulative, nonpoint-source impacts of forest development and the effectiveness of "best management practices" have been debated largely on the basis of "best professional judgments", rather than on scientific experimentation and quantitative monitoring data. Under the FBC's monitoring program, empirical data are being gathered in a cooperative fashion to allow agencies to relate various forest practices to variations in water quality. Another example pertains to the realization (from monitoring data) that many of the basin's very pristine lakes and streams are poorly buffered and will not be resistant to acidic precipitation. Data precipitation chemistry are being gathered to allow early detection of this problem, should it eventuate.

Water resource issues, including all fish, wildlife and water quality concerns, should be managed with the ecosystem as a whole in mind (Cross 1987). Threats to water quality in the Flathead are interactive; management options for one resource component may compromise management objectives for others. Moreover, no resource components should necessarily have priority over others (e.g. fisheries objectives may be of equal importance to nutrient control objectives). The FBC seems to play a pivotal role in coordinating debate and public understanding so that management options will be responsive to the interactive processes that collectively compose the quality of water in the basin. Such coordination requires more complete understanding of the biogeochemistry of the system. The monitoring program of the FBC seems critical and should be refined and expanded.

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CHAPTER 2

Update: Phosphorus Reduction Strategy for Flathead Lake

In April 1984 the Montana Department of Health and Environmental Sciences (DHES)-Water Quality Bureau (WQB) prepared a Strategy for Limiting Phosphorus in Flathead Lake (DHES 1984, 1985a). This strategy was prepared after considerable attention had been focused on Flathead Lakes' phosphorus problem by such groups or organizations as the Steering Committee for the Flathead River Basin Environmental Impact Study, The Flathead Basin Commission, and the University of Montana Flathead Lake Biological Station. The Strategy outlined a six-point plan to reduce phosphorus inputs to the lake:

- impose a 1.0 milligram per liter total phosphorus limit on all state-permitted effluents in the basin
- develop wastewater management plans for unsewered communities in the basin
- recommend legislation to allow the sale of only low or phosphorus-free laundry detergents
- strengthen the control of nonpoint sources of phosphorus
- require subdividers to evaluate the phosphorus absorption capacity of soils where drainfields would be sited near surface water
- expand and refine the phosphorus monitoring program in the basin.

This approach did not single out any one source of phosphorus, but would apply controls to all controllable sources. Not only would this approach be equitable and fair, but scientists are convinced it is necessary in order to make progress towards slowing the rate of lake eutrophication (see Chapter 1, and Stanford 1986).

The WQB distributed the Strategy to public officials, business and conservation groups, and other interested parties, and held a public meeting in Kalispell to clarify the basis and intent of the Strategy. Those who spoke were universally in favor of reversing the deterioration of Flathead Lake (DHES 1985a). This public concern for taking responsible actions to prevent further lake deterioration was reaffirmed in a recent

study conducted by the University of Montana's Bureau of Business and Economic Research (Lenihan and Johnson 1987).

As outlined below, considerable progress has been made in recent years in implementing this strategy.

The 1.0 Milligram Per Liter Phosphorus Limit on State-Permitted Effluents that Reach Flathead Lake

After the WQB drafted the Strategy it began working with municipalities in the basin to meet the proposed 1.0 milligram per liter (1 mg/l) phosphorus effluent limit. Controlling phosphorus in point sources is a two-step process. First, the new phosphorus limit is written into the community's discharge permit, and the community and DHES-WQB agree on a compliance schedule to meet that limit. Then an Advanced Wastewater Treatment (AWT) facility that will achieve the desired reduction of phosphorus is designed and constructed with financial assistance from the DHES-WQB Construction Grants Program (DHES 1985a).

Much headway has been made in the greater Flathead Basin in achieving the 1 mg/l phosphorus discharge limit. With the exception of Kalispell, all facilities discharging to Flathead Lake or its tributaries are in compliance. Interim phosphorus removal facilities are expected to be functional at the Kalispell plant by May 1989 (Anderson 1988).

Bigfork

In 1984 Bigfork received a revised discharge permit from the DHES-WQB that included a target phosphorus limit of 1 mg/l. Subsequently, a construction grant was awarded to replace the 20-year-old plant. The new facility, which provides secondary wastewater treatment and phosphorus removal, began operation in 1988. The plant has worked very well with the effluent discharged significantly below the permit limits for biochemical oxygen demand, total dissolved solids, and phosphorus. The cost of the new facility totaled $2,620,000 (Anderson 1988).

Columbia Falls

Columbia Falls, with financial assistance from DHES, has added a flocculating clarifier to its existing wastewater treatment plant to remove phosphorus. This clarifier, which became operational in 1988, is functioning well and the facility is in compliance with the discharge permit. The project costs were $656,600 (Anderson 1988).

Whitefish

Whitefish has added a new flocculating clarifier and sludge dewatering equipment to the existing aerated lagoon system to add phosphorus removal capability to the facility. These improvements to the Whitefish plant became operational in 1988. The system is performing well with effluent phosphorus typically below permit requirements. The cost for these improvements was $1.61 million (Anderson 1988).

Hungry Horse Dam (U.S. Bureau of Reclamation)

The 1 mg/l phosphorus limit was written into the discharge permit for the wastewater treatment plant at Hungry Horse Dam in 1984. The schedule called for modifications of alum precipitation to the existing facility to attain compliance with the new phosphorus limit. Improvements to the facility are now complete and Hungry Horse Dam is meeting the 1 mg/l phosphorus limit (Anderson 1988).

Flathead Lake Biological Station at Yellow Bay

The sewage facility at the Biological Station serves the station and Yellow Bay State Park. The tertiary process uses alum to precipitate phosphorus out of the wastewater reaching the plant. This facility is currently meeting the 1 mg/l phosphorus limit. In fact, normal effluent contains 0.1 milligrams of phosphorus per liter (Anderson 1988).

Kalispell

The Kalispell wastewater treatment plant has a long history of problems. The existing plant failed to meet the level of wastewater treatment that it was designed to achieve. These problems are compounded by the fact that Ashley Creek, the receiving stream for the plant's discharge, is naturally sluggish in character, has significant man-caused problems throughout its course (Dutton 1987), and has low dissolved oxygen levels above the point of plant discharge (DHES 1985b).

The Kalispell plant is an important contributor of phosphorus and other nutrients to both Ashley Creek and to Flathead Lake. Currently, the Kalispell wastewater treatment plant does not meet the 1 mg/l effluent standard for phosphorus (Anderson 1988).

A construction grant was provided to Kalispell in 1984 to help design plant improvements, including phosphorus removal. Final design of an AWT system for Kalispell was put on hold, however, pending completion of an intensive stream survey of Ashley Creek and a DHES analysis of new proposed effluent limitations for the plant. Included in the DHES analysis was an assessment of alternative discharge locations for the plant including land application, the Flathead River, and Ashley Creek (DHES 1985b). The analysis of alternative discharge points was made because discharge to Ashley Creek during certain times of the year would result in violation of the state's ambient water quality standards for dissolved oxygen (DHES 1985b).

As a result of the DHES analysis and considerable public comment, the City of Kalispell and DHES agreed that the point of discharge for the Kalispell plant should continue to be Ashley Creek. Subsequently, in mid-1988, the Board of Health and Environmental Sciences lowered the minimum dissolved oxygen levels allowed in Ashley Creek. This action was taken because there was sufficient evidence that regardless of the new discharge limits imposed on the city, it was unlikely that the existing standards for dissolved oxygen could be achieved. The existing standard was most probably higher than the oxygen levels that occurred naturally in the creek.

The Flathead Basin Commission supported the lowering of the dissolved oxygen standard for Ashley Creek because the change represented a critical and timely move that would allow the City of Kalispell to proceed with the far bigger task of rebuilding its wastewater treatment plant. Progress on redesign and reconstruction of the plant had been delayed for years pending city, state, and public agreement on the point of discharge for the plant's effluent. The proposed new dissolved oxygen standard would allow Kalispell to discharge to Ashley Creek on a year-round basis under a new and considerably tougher set of discharge standards than that which the city had been previously subject to.

A final discharge permit for the Kalispell plant was issued in November 1988. This permit contains very stringent discharge standards and monitoring requirements, and will result in a rebuilt plant that should rank among the most advanced in the United States. Costs for the new facilities are expected to exceed $4.2 million. In addition, the permit requires interim phosphorus removal to be functional by April 15, 1989. Construction of all facilities is scheduled for completion by August 1991 (Anderson 1988).

Progress Towards Developing Wastewater Management Plans for Unsewered Communities in the Basin

Sewage disposal via septic tank and drainfield is a continuing concern within the Flathead Basin. Unsewered communities, subdivisions, and individual houses may add considerable amounts of phosphorus to local groundwaters. If drainfields are sited too close to lakes or streams, if they are located in areas with high water tables, or if they are placed in soils having inferior phosphorus absorption properties, contamination of both groundwater and surface waters may result. The magnitude of this problem may be illustrated by the fact that approximately one-half of the entire population within the Flathead Basin resides outside of areas served by a public sewage system.

Both Flathead and Lake counties administer programs that require a permit prior to installation or modification of an on-site subsurface disposal system. Both counties have adopted installation standards and conduct onsite inspections prior to permit issuance. These standards are intended to ensure that the system is adequately sized to dispose of the wastewater to be generated. The current standards do not, however, attempt to recognize varying soil conditions and the fact that different soils have differing treatment capabilities (Pilcher 1987).

State authority over onsite sewage disposal systems is currently limited to public systems (serving 25 or more people), or systems submitted as a part of WQB review of subdivisions under the Montana Sanitation in Subdivision Act. Existing regulations allow the DHES to require additional information and data concerning sewage impacts where it has determined that the disposal of sewage may adversely affect the quality of a lake or other state waters. Upon review of such information, the DHES may impose such specific requirements for wastewater treatment and disposal as are necessary to ensure compliance with Montana's Water Quality Act.

Another concern in the Flathead area is that many systems were constructed prior to establishment of current standards and do not meet those standards. Many of these systems are located in close proximity to lakes and streams. Under current regulations, the WQB is able to require replacement of a system and an upgrading to current standards only when a system fails (resulting in surfacing sewage) or where monitoring has documented a violation of water quality standards. As these failed systems are identified, alternate methods of sewage disposal may be required because site limitations (small lot size, bedrock, or high groundwater) may preclude installation of the standard septic tank and drainfield system (Pilcher 1987).

The Flathead Basin Commission places a high priority on encouraging the development of new community wastewater treatment systems where housing density would make such systems feasible. Particular emphasis has been placed on developing a wastewater system for the Evergreen area adjacent to the city of Kalispell. The FBC has also published a brochure entitled, "Understanding Your Septic System," in an effort to improve homeowner understanding regarding how to help prevent improperly functioning septic systems from contaminating groundwater and surface waters.

The following sections summarize the status of proposed and recently completed community wastewater systems in the basin.

Whitefish County Water and Sewer District

Recent studies have indicated that many of the septic systems and drainfields for residences in the Whitefish area were contaminating groundwater and Whitefish Lake (Jourdonnais et al. 1986). The Whitefish County Water and Sewer District lists the following criteria for areas where community wastewater treatment is needed: areas around Whitefish Lake where septic systems have failed, areas where soils and groundwater levels are not suitable for onsite disposal, and areas where existing and projected settlement is very dense. Evidence is not conclusive, however, that all areas are contributing to water quality degradation in the lake (Anderson 1988).

The Whitefish County Water and Sewer District has proposed to sewer eight neighborhoods near Whitefish Lake. The Whitefish County Water and Sewer Facility Plan, which is nearing completion, recommends that all eight areas be tied into the city of Whitefish's wastewater treatment plant. Implementation of these recommendations is meeting opposition because of the city of Whitefish's hesitation to accept additional wastewater at its plant without these areas being annexed to the city. The costs involved in developing connector lines, and the increased costs (taxes) associated with annexation are having a chilling effect on citizen acceptance of the plan. Presently, residents in only two or three of the eight study areas are showing sincere interest in proceeding with construction (Anderson 1988).

Southwest Kalispell

A project is underway to sewer a small residential area adjacent to Kalispell and to have the effluent processed at Kalispell's existing wastewater treatment plant. Project design is near completion with construction scheduled for the spring of 1989. The area is currently unsewered and the high incidence of

septic system failures has resulted in a public health hazard (Anderson 1988).

Bigfork

Bigfork has initiated the planning necessary to sewer areas adjacent to the community. Some of these study areas have malfunctioning systems that are located next to Flathead Lake and could represent a source of contamination to the lake (Anderson 1988).

Lakeside

Construction was recently completed on a $6.1 million sewer system for a large area adjacent to Flathead Lake. The project consists of a collection system and the pumping of raw sewage seven miles to a site north of Somers. The sewage is treated in aerated lagoons with storage and then discharged to a spray irrigation system designed to use the nutrients for crop growth.

Lakeside's system is generally working well, although insufficient flow has accumulated to utilize the spray irrigation system. A minor odor problem associated with the wastewater pump stations has occurred. Measures to correct the problem are currently being considered by the project engineer (Anderson 1988).

A facility plan is currently being prepared to evaluate the connection of the community of Somers (Figure 22) to the recently completed Lakeside facility, as well as some residences located between Lakeside and Somers (Anderson 1988).

Big Arm

The draft facilities plan recently completed for this area recommended that a collection and treatment system similar to that at Lakeside be constructed. The high estimated cost of this project, however, may become a significant local issue (Anderson 1988).

Woodland Park

All forty homes in this area adjacent to Kalispell were connected to the Kalispell wastewater treatment plant in the summer of 1987 (Anderson 1988).

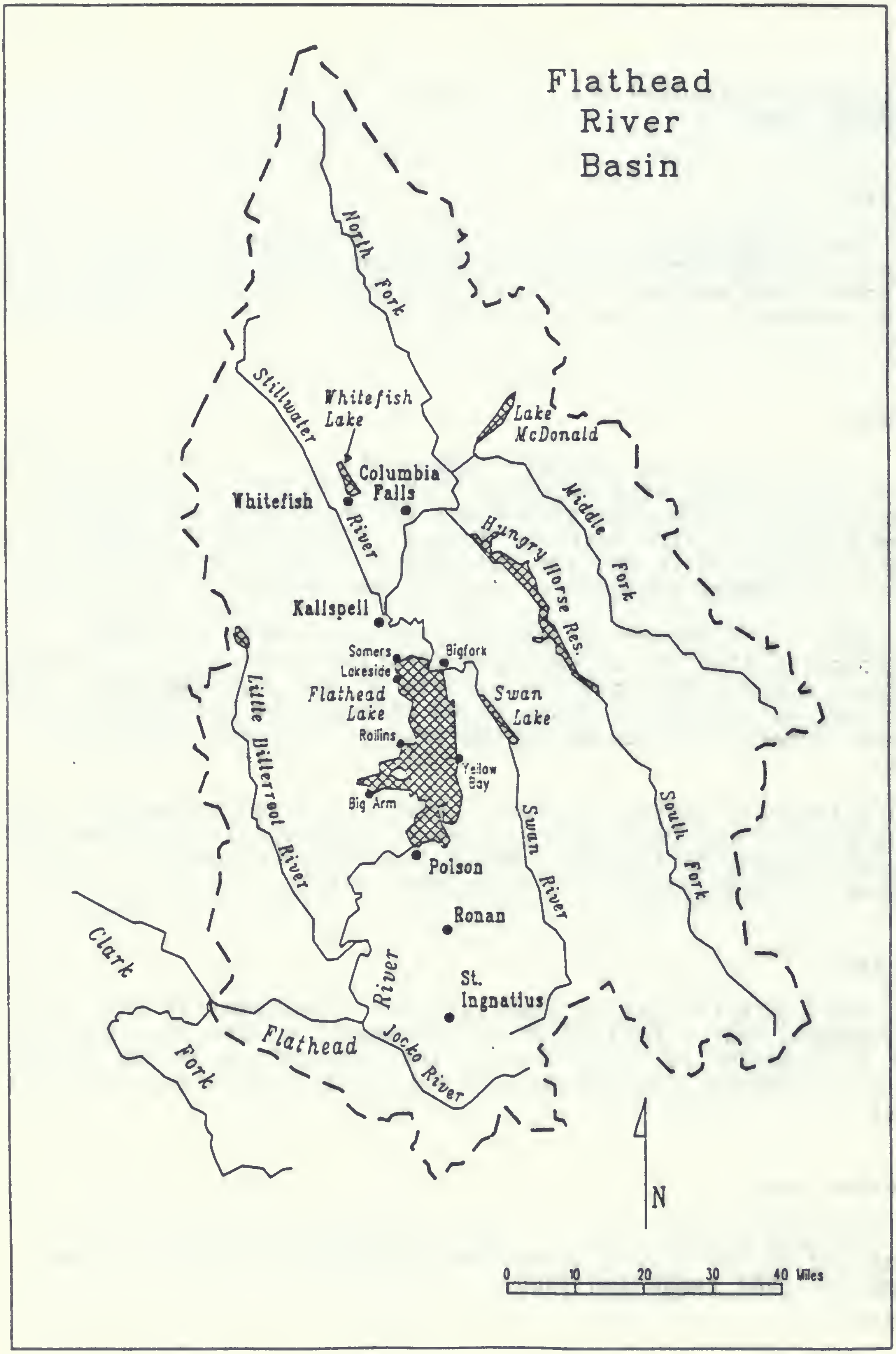

FIGURE 22. THE FLATHEAD RIVER DRAINAGE

Evergreen

Scientific studies of the problem. Evergreen is an unincorporated community on the eastern edge of Kalispell. The impact of human activity on surface water and groundwater in the Evergreen area has been documented in numerous scientific studies (Konizeski and Brietkrietz 1968; Spratt 1980; Noble and Stanford 1986; King 1988). Impacts include improperly functioning septic systems, industrial pollution, well water contamination, and elevated levels of nutrients in the Flathead River after flowing through the Evergreen area.

Spratt (1980) documented the hydraulic connection between the Flathead River and the shallow gravel aquifer underlying the Evergreen area, and concluded that the aquifer was being polluted with nutrients and bacteria by septic tank effluent. Noble and Stanford (1986) documented significant urban pollution, most likely septic leachate and street runoff, of the shallow gravel aquifer underlying the Evergreen area. They showed that nitrate and phosphorus is discharged rapidly from the aquifer into the Flathead River and ultimately, Flathead Lake. King (1988), in a study of two individual septic tanks in the Evergreen area, observed that both systems were actively contaminating the underlying groundwater with nitrate and phosphorus derived from septic effluent.

Early planning efforts. In 1983 Flathead County and the City of Kalispell, in association with the Evergreen Water and Sewer District Board (Board), received an EPA construction grant through DHES for the purposes of developing a cost-effective solution to the Evergreen septic problem. Approximately $90,000 has been expended to date for preparation of the facility plan, 75 percent of which was paid by the EPA and the remainder by Flathead County.

Preliminary results of the facility planning efforts were presented to the public in July 1984. The recommended solution at that time consisted of a collection system that utilized existing septic tanks for preliminary wastewater treatment and a small diameter collection system to transport the septic tank effluent, minus the solids settled out in individual septic tanks, to an aerated lagoon system. The lagoon system would provide treatment and storage of the waste. Final disposal would be by spray irrigation on cropland. The proposal stipulated that the Evergreen Water and Sewer District would routinely clean and maintain the septic tanks and be responsible for properly disposing of the tank contents. The range of annual user charges for this system were projected to be $180-$240 (Stahly Engineering & Associates 1983). Estimated construction costs for this "small diameter pipeline" project were $10,700,000.

Approximately $7,450,000 of this amount would have been paid by an EPA construction grant with the "local share" coming from a low-interest loan from the Montana Department of Natural Resources and Conservation (DNRC).

In 1985 a bond election was held in Evergreen for the purpose of allowing the District to borrow the necessary "local share" from DNRC. Although a majority of the voters approved the loan, the bond issue failed because less than 60 percent of the registered voters returned ballots as requested by state law. A second bond issue in 1986 also failed to receive the necessary 60 percent majority. Some of the probable reasons for the bond issue failures included:

- residents were not well informed about the project
- a conventional collection system was preferred, rather than the small diameter system with septic tanks as recommended in the Draft Facility Plan
- user costs were too high
- many residents may not have noticed any problems with their septic system and were not convinced that a collection/treatment system was needed
- residents did not want a wastewater treatment plant located in Evergreen
- some believed that construction of a sewage system would lead to excessive and uncontrollable growth in Evergreen.

Recent planning efforts. In late 1987 several members of the Evergreen business community presented the Evergreen Water and Sewer District Board with petitions showing that many local businesses were in favor of some form of centralized sewer project. An informal poll taken in November 1987 in the Evergreen Water District found 59 percent of the respondents also in favor of some form of sewer system (Cheman 1987). With these and other positive indicators, planning efforts towards a centralized sewer system for the Evergreen area have been renewed.

The WQB has been working with the Board and its contracted engineering firm to modify and finalize the Facility Plan initiated in 1983. The modified plan will contain recommendations that will hopefully be more acceptable to the Evergreen residents. Modifications and alternatives to be presented in the Final Facility Plan tentatively include:

- An alternative that would provide for a sewage system only in those parts of Evergreen where the residents want sewer service. This alternative would not financially encumber others in the district. However, non-participating neighborhoods would still be required to upgrade their septic systems to assure complete groundwater and surface water protection.

- An alternative that would provide for a conventional sewer system as opposed to the "small diameter system" proposed in 1985. A "conventional system" collects the untreated wastewater directly from a home or business and transports it to a centralized treatment facility. The original Facility Plan evaluated both types of systems and found the small diameter system to be the most cost effective. The Facility Plan is now being revised to evaluate using different systems for the various areas to be sewered.

- Cost estimates for treatment and disposal are being re-evaluated to determine whether an alternative can be found that would reduce user charges. One alternative considered in an earlier version of the Facility Plan was to process the Evergreen sewage at the Kalispell plant (Stahly Engineering and Associates 1983, 1988). Several of the assumptions used in preparing the original cost estimates were subsequently determined to be invalid and are being revised. Negotiations with Kalispell regarding treatment charges, hook-up fees, and operating maintenance charges are ongoing to establish the conditions under which Kalispell would accept Evergreen's sewage.

- Consideration of other possible funding alternatives for providing the local share of the development costs. One possibility would be the formation of a Rural Special Improvement District.

Completion of the Facility Plan represents a large step towards agreement on whether or not an Evergreen community wastewater treatment system will be constructed in the near future. The timing of such a decision is becoming increasingly important. Recently, the EPA has reduced the percentage of the wastewater treatment system costs that it can provide to qualifiying communities. Furthermore, in the near future EPA construction grants will be replaced by a revolving loan program. Given these fiscal realities, if an Evergreen sewer plan is not approved by late 1989, it is unlikely that adequate funds will be available to complete the project (Anderson 1988).

Wastewater management is a community issue. By working together, Evergreen citizens can develop a plan that is right for their needs, protects water quality and public health, and fosters the betterment of their community. Citizens are urged to participate in the Facility planning process. For more information, please contact the Chairman of the Evergreen Water and Sewer District or the Flathead Basin Commission.

Legislation Allowing the Sale of Only Low or Phosphorus-free Detergents

The 1987 Montana Legislature passed House Bill 711; legislation that enables counties to adopt a model rule restricting the phosphorus content of detergents. This legislation was introduced by legislators from the Flathead Valley and was supported by the Flathead Basin Commission, the DHES-WQB, local Chambers of Commerce, the EPA, and many others. The reason for passing this legislation is that phosphorus had been identified as the limiting element for algal growth in Flathead Lake, and because a substantial amount of the biologically available phosphorus reaching the lake comes from basin wastewater treatment plant discharges and from improperly functioning septic systems (Chapter 1).

House Bill 711 directed the DHES to draft the model rule (see Appendix G), and stated that counties could not modify this rule should they decide to restrict the sale of phosphorus-based detergents. The law gives counties the power to enforce the rule and directs that enforcement be applied to the sellers, not to the users of phosphorus-based detergents. Cleaning agents used for industrial purposes and for cleaning food processing, dairy, and medical equipment are exempted from the provisions of the rule.

House Bill 711 further specifies that a county may adopt the rule only after it has found that:

- the county has a natural lake, whether or not it is fitted with a dam, and for which DHES or the county governing body has determined that eutrophication enhanced by human activity is occurring and that phosphorus is the limiting factor; and

- other efforts are being undertaken in the county to reduce the amount of phosphorus entering surface waters.

The Flathead and Lake County Commissioners each held hearings on the proposed phosphorus detergent rule. Extensive testimony was presented at these hearings to show that sufficient information existed for the Commissioners to make the above findings (in particular: Zackheim and Cooper 1983; Bahls 1986; and Stanford 1986). The DHES "Strategy for Limiting Phosphorus in Flathead Lake" (DHES 1984, 1985a), provided an excellent summary of other efforts being undertaken in the two counties to reduce the amount of phosphorus entering surface waters.

Both counties adopted the model rule, and since December 6, 1986 in Flathead County and January 1, 1987 in Lake County, the sale of phosphorus-based detergents has been prohibited, except for those compounds exempted.

The Flathead Basin Commission has received few complaints regarding the removal of phosphorus-based detergents from local store shelves. Nonphosphorus substitutes are plentiful. Furthermore, as Dr. Stanford points out in Chapter 1 (pp. 1-29 and 1-30), the phosphorus detergent ban appears to be substantially reducing the levels of phosphorus in wastewater reaching the four largest wastewater treatment facilities in the basin. Such a reduction not only reduces phosphorus loading in Flathead Lake, but it also reduces the costs of removing phosphorus at the plants.

Strengthening the Control of Nonpoint Sources of Phosphorus

The fourth recommendation in the DHES phosphorus control strategy was the implementation of a nonpoint source pollution control program to control nutrients from forest activities, agricultural production, land development, and urban runoff. Control of nonpoint sources of phosphorus is both difficult and expensive. Because phosphorus is usually absorbed onto sediment, control of phosphorus also involves sediment control. In the Flathead, where there are few man-caused problem areas that are known to generate significant amounts of nonpoint source sediment or phosphorus, phosphorus control is more prevention than cure (DHES 1985a).

Except for regulations that protect streambanks and govern wastewater disposal in subdivisions, the control of nonpoint sources of sediment and phosphorus is voluntary.

Efforts to protect the high quality waters of the Flathead Basin from nonpoint source pollution are underway on several fronts:

- The Environmental Quality Council has recently recommended a multi-faceted program to protect forested watersheds from potential water quality impairment caused by forest practices (EQC 1988). These recommendations culminated a two-year study under HJR 49.

- The Nonpoint Source Management Plan submitted by DHES to EPA under Section 319 of the Federal Clean Water Act proposes statewide agriculture and silviculture programs that include best management practices, education, and watershed demonstration projects. One proposed demonstration project, East Spring Creek in the Evergreen area, would be located in the Flathead. DHES is pursuing funding from a variety of state, federal, and private sources to finance these programs.

- The Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program (a consortium of researchers and management personnel from private industry, state and federal government, and the university system -see Chapter 3) is an "adaptive management" program that is intended to document, evaluate, and monitor whether forest practices affect water quality and fisheries within the Flathead Basin and to establish a process to utilize this information to develop criteria and administrative procedures for protecting water quality and fisheries. The program was initiated in July 1988 and funding has been secured for studies through 1990. Several study "modules" have been approved by the program coordinating team.

- The Montana Cumulative Watershed Effects Cooperative was formed in 1984, at the encouragement of the State Forester, to promote cooperative timber sale planning to help mitigate cumulative watershed effects caused by logging practices. Members of the Cooperative include state and federal managers of commercial forest lands in the Flathead, large industrial timber companies, and such agencies as the Department of State Lands, the DHES, the Department of Fish, Wildlife and Parks, and the DNRC (Conservation Districts Division). An initial effort of the cooperative was the development of a memorandum of understanding through which the members endorsed and agreed to apply a set of best management practices for forestry in Montana. Recently the Cooperative has focused on the issue of cumulative watershed effects and members are attempting to develop a methodology for determining when such effects occur and a process for specifying how to resolve potential problems (EQC 1988).

- The Flathead River International Study Board recently presented its report on the potential water quality effects of the proposed coal mine in British Columbia. This report will form the basis of subsequent deliberations and recommendations to the International Joint Commission to protect water quality in the Flathead from this potential nonpoint source of pollution.

- In January 1987 the Flathead Conservation District completed a streambank inventory and nonpoint source pollution survey of the Ashley Creek stream corridor (Dutton 1987). This document will help local officials identify and manage nonpoint source problems in the Ashley Creek drainage.

- Sewering of Lakeside, Evergreen, Big Arm, and other areas will diminish nonpoint source pollution from septic tank drainfields.

With adequate funding for research, planning, and regulatory and voluntary management programs, responsible agencies may continue to protect water resources in the Flathead from impacts caused by nonpoint sources of pollution.

<u>Requiring Subdividers to Evaluate the Phosphorus Absorption Capacity of Soils where Drainfields would be near Flowing Water</u>

Much of the subdivision activity occurs near the lakes and streams that provide natural beauty to the area. Most homes outside of municipal areas utilize the septic tank and drainfield method of sewage disposal. A review of soils in the area revealed that many did little to remove phosphorus from domestic wastewater (DHES 1985b).

In December 1984 the Montana Surface Water Quality Standards were amended by the Montana Board of Health and Environmental Sciences to allow closer review of sewage systems that might be impacting lakes and streams. The rules now state that where the DHES has determined that the disposal of sewage may adversely affect the quality of a lake or other state water, the DHES may require additional information concerning such possible effects. It may then impose specific requirements of wastewater treatment as necessary to ensure compliance with the Montana Water Quality Act.

Accordingly, when an application for subdivision approval is reviewed for a parcel of land located within one-half mile of any surface water, it is reviewed for adequacy of nutrient removal. Specific data may be requested to determine the ability of soils at that site to remove nutrients. If calculations reveal that nutrients will reach state waters within a 50-year period, additional treatment is required prior to approval. One problem with this process is that many land splits, and hence many new home construction projects in the Flathead, occur outside of the subdivision approval process.

Expand and Refine the Phosphorus Monitoring Program in the Basin

A key responsibility of the FBC is to coordinate the collection of water quality monitoring data within the basin and to periodically report to the public on the status of, and trends in such quality. Chapter 1 describes the FBC's master plan for monitoring surface water quality in the basin (Flathead Basin Commission 1986). This chapter also provides a status report on the condition of the basin's waters including the problem of phosphorus. Fifteen separate agencies or companies are involved in portions of the monitoring plan.

The FBC will continue to coordinate water quality monitoring activities in the basin and will seek agreement among all cooperators regarding how the plan can be refined and expanded to better identify the amounts of phosphorus and other pollutants contributed by various point and nonpoint sources. The FBC will also continue to encourage government agencies and others to fund this critical interagency effort.

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CHAPTER 3

Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program

Many of the major landowners and resource-managing agencies in the Flathead River Basin jointly signed a Memorandum of Understanding (MOU) effective August 29, 1988, establishing the Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program (Cooperative Program). Through the Cooperative Program, the agencies will contribute funding to sponsor research projects intended to provide specific information documenting the relationship between forest practices and water quality/fisheries in the Flathead River Basin.

Statement of the Problem

Approximately one-third of the 5.5 million acres that comprise the Flathead Basin watershed is commercial timberland. These lands produce wood products that provide about 28 percent of the basic employment income in the region. In addition, an abundance of clean lakes, rivers, and streams has given the Flathead Basin a national reputation for high quality water resources and recreational opportunities (EPA 1983).

Studies in other watersheds have shown that certain forest practices (e.g., timber harvesting and associated road construction) adversely affect water quality and fisheries, primarily through the introduction of additional sediment into aquatic systems and by changing seasonal streamflow patterns. Instream sediment increases can significantly reduce suitable habitat and decrease populations of aquatic insects and fish, render surface water unsuitable for drinking water supplies or necessitate costly filtration, and impair the beneficial use of water for recreation and agriculture.

In many instances, impacts of forest practices on water quality are subtle and difficult to quantify. In Idaho, however, certain forest practices have been linked with significant damage to watersheds and fisheries (Wann 1987). Slope, soil type, precipitation, method of timber harvest, and road construction and maintenance techniques are among the variables that have been shown to influence the effects of forest practices on a watershed.

In Montana, and particularly in the Flathead River Basin, existing interpretations of the effects of local forest practices on water quality and fisheries are difficult to substantiate. Under the auspices of the statewide 208 water quality planning

effort, the U.S. Forest Service (1978) and Rassmussen and Culwell (1978) reported several hundred sites on federal, state, and private land in Montana where forest practices were impairing water quality and associated uses. Recently, the Montana Department of Health and Environmental Sciences estimated that 450 miles of Montana streams are impaired from increased sedimentation caused by forest practices (DHES 1986). In addition, culturally-derived nonpoint sources (including forest practices and other sources) have been estimated to contribute 10 percent of the phosphorus that reaches Flathead Lake each year (DHES 1986). This estimate, however, is not based on site-specific research. Even the U.S. Forest Service (USFS), which has been monitoring timber-harvesting activities and streams for decades, acknowledges that a consistent data base has not been developed that would clearly establish the relationship between baseline stream water quality and forest practice impacts (USFS 1984). Similarly, the Flathead Basin Commission Master Plan for water quality monitoring, implemented in 1985, is not designed to specifically identify the cause-and-effect relationship between forest practices and water quality in the basin.

The rate of timber harvest in the Flathead River Basin has accelerated in recent years, particularly on privately-owned timberlands. In addition, implementation of the Flathead National Forest Plan will provide new opportunities for timber harvest and road-building activities in sensitive headwater drainages in the basin. These drainages are characterized by steep slopes and poorly developed soils that have significant potential, if developed for timber harvest, to contribute to increased sedimentation of streams. Many of these areas provide important spawning and rearing habitat for sport fisheries. Bull trout and cutthroat trout populations in the upper Flathead River Basin are a valuable economic and recreational resource (Duffield et al. 1987), and are considered highly sensitive to habitat disturbance (EPA 1983). The most extensive scientific review to date on the issue (Chapman 1987) concludes there are considerable uncertainties about how best to quantify the effects of sediment on fish populations. This review also identifies a crucial need for integrated watershed/fisheries studies to address these important questions.

The growing concern about the potential watershed impacts associated with forest practices is reflected in the Montana Legislature's passage of House Joint Resolution (HJR) 49, a bill that directs the Environmental Quality Council to conduct a two-year investigation of the relationship between forest management and watershed effects. Similar concerns have been expressed in appeals of national forest plans and individual timber sales, as well as in the increased public scrutiny of timber management programs of state-owned and privately-owned lands. Timber managers and purchasers, as well as area residents dependent upon the wood products industry for their livelihood, are in turn

affected as logging operations are delayed pending the need to further consider and document potential watershed impacts.

In sum, the need for additional information that documents the cause-and-effect relationship between forest practices and potential watershed impacts in the Flathead River Basin has been identified by the Flathead Basin Commission as a priority. Uncertain environmental effects, and sensitive, economically valuable resources that are potentially at risk reinforce the need for the establishment of a data collection and analysis program designed to address this key issue. In addition, a process is needed to utilize this information, if detrimental impacts exist, to develop criteria and administrative procedures to assure the continued well-being of the basin's water quality and fisheries.

Project Description

In response to the needs discussed previously, major land and resource managing agencies in the Flathead River Basin established the Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program by jointly signing an MOU in August 1988 (Appendix D). The Cooperative Program represents a concerted and coordinated effort by state, federal, and private interests to work together to learn how, and if, forest practices are adversely affecting water quality and fisheries, and to develop methods to utilize the findings in the management of Flathead River Basin timberlands. The Cooperative Program has initially authorized seven closely related research and monitoring projects, and has established the organizational framework to coordinate additional future projects if necessary (Appendix D).

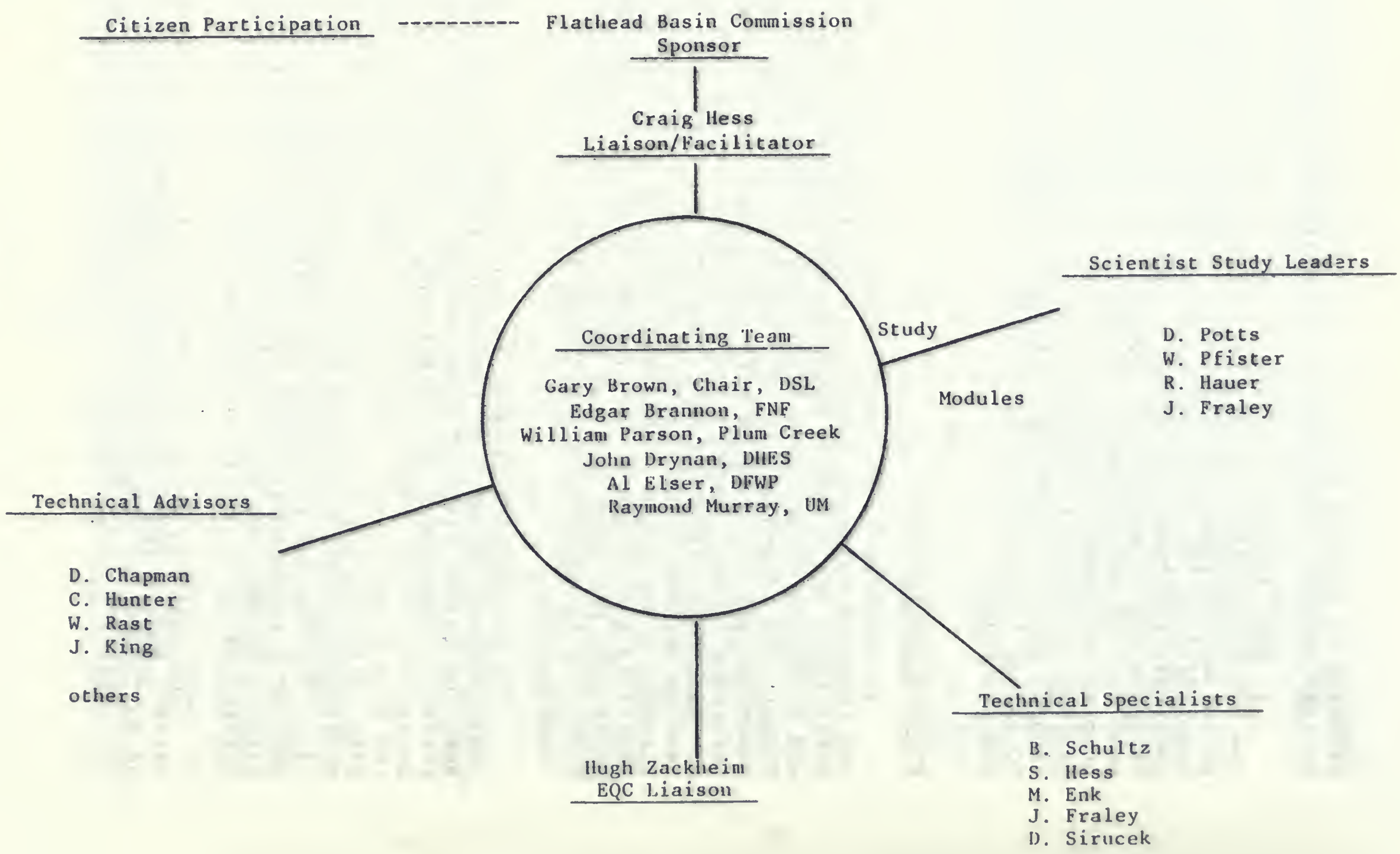
The Cooperative Program is administered by a Coordinating Team representing many of the major land and resource managing agencies in the Flathead River Basin. These include the State Forester (Department of State Lands, Division of Forestry), the Supervisor of the Flathead National Forest, representatives of the Plum Creek Timber Company Inc., the Montana Department of Fish, Wildlife and Parks, the Montana Department of Health and Environmental Sciences, and the University of Montana (Figure 23). The Montana Environmental Quality Council (EQC) will provide a representative to serve on the Coordinating Team as a liaison between the EQC's study of forest practices and the efforts of the Cooperative Program.

The Flathead Basin Commission is the nominal sponsor of the effort, and is providing logistical and staff support and serving as an "umbrella" organization under which the Cooperative Program will operate. Each research project will be directed by a

FIGURE 23

FLATHEAD BASIN FOREST PRACTICES,
WATER QUALITY, AND FISHERIES COOPERATIVE PROGRAM

Organization



scientific study leader, while resource specialists from various organizations will contribute technical assistance as needed. Citizen participation in the Cooperative Program will be encouraged and coordinated through the Flathead Basin Commission.

Purpose and Specific Objectives

The purpose of the Cooperative Program is to improve the management of Flathead area watersheds through the development and application of state-of-the-art information to prevent or mitigate the potential adverse effects of specific forest practices on water quality and fisheries.

Specific objectives of the program are to document, evaluate, and monitor whether forest practices affect water quality and fisheries within the Flathead Basin and to establish a process to utilize this information, if detrimental impacts exist, to develop criteria and administrative procedures for protecting water quality and fisheries.

Funding

The Flathead Basin Commission will provide operational oversight and will coordinate the expenditure of contributed funds necessary for operation of the Cooperative Program. Financial, technical, and in-kind contributions will be provided by all participants of the Cooperative Program. In addition, research projects implemented by the Cooperative Program will incorporate ongoing research projects funded in part through MacIntire-Stennis Research Program funds and the Montana Riparian Association.

The Cooperative Program MOU establishes the following funding contributions from public and private sources: Flathead National Forest, State of Montana Renewable Resource Development Grant (application submitted), Plum Creek Timber Co. Inc., and other State of Montana sources. The budget for the Cooperative Program is provided in Appendix B-7.

Implementation

Individual research projects will be implemented by each of the scientific study leaders following peer review of a detailed study plan, approval of the study plan by the Cooperative Program's Coordinating Team, and allocation of available research funds. Study leaders will be responsible for conducting individual research projects in compliance with each detailed study plan. The Cooperative Program's Coordinating Team will review annual work plans and semi-annual progress reports, offer

suggestions, encourage scientific team efforts, and facilitate appropriate technical assistance from resource specialists from the various organizations involved in timberland management and oversight in the Flathead River Basin.

Project Results

A series of project reports and, in some cases, scientific publications addressing how certain forest practices affect water quality and fisheries in the Flathead River Basin will be the initial product of the research, monitoring, and analysis conducted though the Cooperative Program. An important additional product of the Cooperative Program will be the opportunity for timberland resource managers to apply the research results to the future management and protection of the basin's forest resources.

The reports and publications derived from the separate research efforts are intended to provide scientific assessments of the cause-and-effect relationships between specific forest practices and water quality/fisheries, and to identify planning tools necessary to reduce potential adverse environmental effects of timber harvest.

Through the scientific assessments, researchers will develop new information on timber harvesting-sediment-fishery relationships. This information will fill an important gap in understanding, and can help to form the basis for future monitoring of timber harvest-related impacts in the basin.

Research projects that assess the use of Best Management Practices (BMPs) will develop planning tools for timber harvesting operations, develop a risk assessment ranking for watersheds, develop riparian management guidelines, and adapt a geographic information system (GIS) for use in forest management within the basin. These research projects can help provide site-specific resource information for timber harvesting operations, as well as indicate sensitive sites and forest practices (BMPs) necessary to harvest timber without causing significant adverse watershed impacts.

The administrative structure of the Cooperative Program is highly conducive to directing the research results into effective on-the-ground management. The research results will be shared by all parties, encouraging increased understanding and improvement of forest management practices in the basin.

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CHAPTER 4

The Flathead Basin Commission's Public Education Program

One of the primary responsibilities of the Flathead Basin Commission is to provide a regional forum for the discussion of water quality and related issues. Another key responsibility is to serve as a credible information source and information synthesizer.

With these objectives in mind, the FBC began a formal public education effort regarding threats to the basin's water quality in 1986. In establishing this program, the FBC recognized that both land management and regulatory agencies have identified the steps that need to be taken to protect the Flathead's water resources. Strong public understanding, and hence support, is what is now needed if these management decisions are to be implemented. Building public support for protecting basin waters is one of the FBC's primary objectives.

To implement the Public Education Program, the FBC secured private funding from the Minnesota-based Freshwater Foundation, which had received a grant from the Northwest Area Foundation to assist the FBC. The grant enabled the FBC to open an office in Kalispell and to staff it with two part-time employees. Funding for compensation of this staff for the second year of the Public Education Program has been raised from a variety of private and public sources in Montana. Office space in Kalispell was donated by Flathead County. The budget for the Public Education Program is explained in Appendices B-4, B-5, and B-6.

The Public Education Program consists of a series of events, projects, and publications regarding the maintenance of clean water in the Flathead Basin and its relationship to the area's economic viability. These programs are described below.

Slide Show

A slide show with narration has been prepared that portrays the relationship between clean water and the basin's economy and quality of life (Flathead Basin Commission 1986). The slide show is being used by the Public Education Coordinator and by FBC members in presentations to interest groups, civic organizations, schools, and other groups. Since the Public Education Program was initiated, over 65 group presentations utilizing the slide show have been conducted. In addition,

approximately 1,200 high school students have heard presentations by the Public Education Coordinator.

Breakfast Seminars

Three out-of-state speakers have been brought into the basin by the FBC to give breakfast seminars. The purpose is to inform community leaders of how other states are successfully addressing complex water quality problems similar to those facing the citizens in the Flathead Basin. Seminars have been given in each of the five principal basin communities.

The first speaker was Bill Morgan, the Director of the Tahoe Regional Planning Agency. Mr. Morgan presented information about the planning efforts that his agency is responsible for enforcing in the Lake Tahoe Basin of California and Nevada. Such efforts are designed to protect Lake Tahoe's water quality.

The second speaker was Ken Lustig, the Environment Health Director for Idaho's Panhandle Health District. Mr. Lustig described how sewer management agreements have been effectively used to protect groundwater quality while encouraging orderly urban development in Idaho's Prairie-Rathdrum aquifer area.

The third speaker was Robert Herbst, the Executive Director of Trout Unlimited in Washington, D.C. Mr. Herbst's talk focused on the economic importance of water-based recreation in areas such as the Flathead Valley. Mr. Herbst also discussed his experiences regarding innovative actions to protect or improve water quality in other regions of the country.

In addition to the breakfast seminars, the three speakers each participated in other workshops or panel discussions while they were in the basin. Over 350 Flathead area residents attended the breakfast seminars, workshops, and panel discussions.

Brochures

Two informational brochures on key water-related issues facing basin residents have been written and distributed by the FBC. These included: "Phosphorus and Water Quality in the Flathead Basin" (Flathead Basin Commission and Freshwater Foundation 1987a), and "Understanding Your Septic System" (Flathead Basin Commission and Freshwater Foundation 1987b).

Three other brochures will be completed in 1989. These have been tentatively entitled, "Nonpoint Pollution in the Flathead Basin," the "Economic Value of Water Quality," and "Water Quality and Land Use Planning."

"Phosphorus and Water Quality in the Flathead Basin" was designed to state the dimension of the phosphorus problem in Flathead Lake and its potential impact on water quality in the lake. This brochure has been distributed to 5,000 basin residents (Freshwater Foundation 1988).

"Understanding Your Septic System" explains the operation and maintenance of septic systems and their potential for contaminating groundwater and surface water when not properly maintained. Septic systems in certain areas around Flathead Lake, Whitefish Lake, and other lakes in the basin are leaking nutrients, including phosphorus, into the lake. Not only is the water quality of Flathead Lake adversely affected, but the potential for local groundwater contamination is also significant. Over 3,000 of these brochures have been distributed throughout the basin (Freshwater Foundation 1988).

Public Service Announcements

Four public service announcements (PSAs) have been prepared and shown on area television stations since the summer of 1987. These 60-second messages have focused on how septic systems work and sometimes fail, the economic value of water resources protection, Flathead Lake water quality, and groundwater quality (Flathead Basin Commission 1987a, 1987b, 1988b, 1988c). It is the FBC's intent for these PSAs to be periodically rebroadcast.

Water Quality Conference

In April 1988 the FBC hosted a major two-day conference during which 30 distinguished speakers discussed water issues facing the basin's citizens. The conference was entitled, "Our Clean Water--Flathead's Resource of the Future", and was attended by 215 people (Flathead Basin Commission 1988a).

The conference began by examining the state of the region, including a review of past water quality efforts and a discussion of the current status of water conditions in the basin. It also included a panel presentation that focused on the effectiveness of governmental regulations designed to protect water quality. Experts from neighboring western states presented case studies that showed how water quality conflicts are being resolved in their areas.

The relationship between clean water and the Flathead area's economic future was the speakers' major focus during the second day of the conference. The conference ended with participants making recommendations to the FBC regarding where it should focus its future actions.

These recommendations included:

- Expand the membership base of the FBC. Define more clearly the role of the FBC and how the composition of the FBC serves that role.

- Develop a funding program for the FBC that places a greater share of the FBC's program costs on the citizens of the Flathead Basin. The challenge is not to create another bureaucracy, but instead to develop a network procedure that uses the strengths of groups and agencies that already exist in the basin.

- Continue the existing role that the FBC serves in providing people with current and accurate information regarding the water issues in the basin.

- Provide support for responsible land use planning and regulation in the basin. Many of the current water quality problems in the basin can be tied to past land use planning efforts that were either inadequate or nonexistent. If the Flathead Basin is to experience both economic growth and a quality environment, it can't expect this to happen "by chance". The Flathead Basin Commission can be a facilitator for responsible, citizen-supported land use regulation.

- Continue and expand the FBC's existing efforts to monitor and evaluate the condition of water quality in the basin. The FBC, with the assistance of research scientists and government agencies, should serve as a source of public information regarding changes in the basin's water quality, and the reasons for such changes. The FBC's current program should be expanded to include groundwater, landfill sites, forestry practices, pesticides, and other nonpoint water pollution sources (Flathead Basin Commission 1988a).

Copies of the conference proceedings are available from the FBC offices in Kalispell and Helena, as well as in area libraries.

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CHAPTER 5

Land Use and Development Trends in the Flathead Basin

Changes in land use and development are important indicators of an area's economy and character. Land use activities can also impact air quality, water quality, wildlife habitat, and other resource values. This chapter summarizes population growth, housing construction, land division, and recent commercial development projects in the Flathead Basin to indicate trends in land use and development.

Population

The population of Flathead and Lake counties in 1985 was estimated to be 56,800 in Flathead County, and 20,800 in Lake County. This represents an approximate 9 percent population increase since 1980 and a rate of increase almost twice that of the state over the same period. However, the rate of population growth over the first five years of this decade is about one-half the rate of growth in the Flathead Basin between 1970-1980. There was a growth rate of 32 percent during that period (Jentz 1987; Sorenson 1987).

Housing Construction

New housing construction in the rural areas of Flathead County has remained relatively stable over the last four years at about 300 new homes per year. In addition, about 100 new mobile homes have been installed each year in the rural areas. New residential construction in the incorporated community of Whitefish has remained fairly stable over the last four years at about 50 units per year. Approximately half of these units have been duplex or multi-family dwellings. Historical data for the incorporated cities of Kalispell and Columbia Falls were not available. However, in 1985 there were 155 housing units constructed in Kalispell, of which 140 units were duplex or multi-family. In Columbia Falls, 20 housing units were built in 1985, of which 15 were multi-family (Jentz 1987; Sorenson 1987).

Approximately 540 new homes have been built in the rural area of Lake County over the last five years. During this time period, new construction has ranged from a high of 146 units in 1984, to a low of 84 units in 1986.

Twelve new homes and two four-plexes have been built in the city of Ronan over the last four years. In Polson, 108 buildings have been constructed for residential purposes over the last five years, of which 81 were single-family and 78 were multi-family units. There was a high of 55 units built in 1988 and a low of 4 units built in 1985 (Sorenson 1987).

Land Division

The majority of new lots in the rural area of Flathead County between 1982 and 1985 were created by use of the exemptions from the state subdivision law, and thus have avoided public review. A total of 1,455 lots were created during this time period by use of exemptions for an average of 363 lots per year. During the same four-year period, 400 lots were created in the rural areas and were filed as subdivision plats after undergoing a public review process. The public review process evaluates public interest criteria to determine if a development should be approved. These criteria include basis of need; expressed public opinion; and effects on agriculture, local services, taxation, wildlife, natural environment, and public health and safety. As these data indicate, only approximately 20 percent of the new land divisions in the rural areas of Flathead County were analyzed for impacts on the community and environment (Jentz 1987; Sorenson 1987).

During the same period (1982-85), 257 lots were created within or adjacent to the three incorporated communities in Flathead County. This compares to approximately 1,800 lots created in rural areas and indicates that new land divisions for residential purposes are more prevalent in the rural areas of the county. However, information is not available that indicates the number of vacant lots available in the county.

In Lake County, approximately 1,000 acres were split into 206 lots between 1982 and 1985 by use of the exemptions from state law. During this same period, approximately 1,400 acres were split into 65 tracts, each about 20 acres in size. State law allows land to be divided into 20-acre parcels or greater with no subdivision review. Compared to the previous four years (1978-1982), 1,500 acres were split into 310 lots by use of exemptions, and 6,500 acres were split into 315 tracts of about 20 acres in size (Sorenson 1987).

Between 1982-85, 122 lots were created in Lake County through the subdivision review process (37 percent of total created). This compares to 367 lots created through subdivision review between 1978-1982. As is the case with Flathead County, the vast majority of land divisions over the last eight years in Lake County have been rural areas. For reviewed subdivisions, about 50 percent of the lots created have been lakefront or view

lots on Flathead Lake. Since 1980, four recreational vehicle campgrounds have been developed around Flathead Lake within Lake County that provided 128 R.V. spaces (Jentz 1987).

Recent and Potential Development Projects

The wood products industry is the largest base employer in Flathead County, but tourism and retail trade are the fasting growing sectors of the economy. Some recent developments include construction of new malls in Kalispell and Whitefish, expansion of the Outlaw Inn and the Levengoods Motel, and development of the Grouse Mountain convention center and motel at Whitefish, the Bigfork Harbor Marina and Condominiums, and the Eagle Bend Golf Course at Bigfork. A recent study for the Big Mountain Ski Resort showed that skiers spend approximately $24 million per year in the Flathead. Big Mountain is planning major expansion of its facilities that will further enhance revenue spent in the valley (Jentz 1987).

In Lake County, agriculture is the largest base employer and employs approximately 20 percent of the work force. Like Flathead County, tourism and retail trade appear to be the major growth sections of the economy. There are about 25 manufacturing operations of various sizes in Lake County. A new golf course is planned in Ronan, and Polson hopes to expand its course to 18 holes. The Confederated Salish and Kootenai Tribes manage timber resources on the reservation and operate a post and pole business in Dixon. The tribes have established and are expanding a community college in Pablo, and also operate an electronics firm there (Sorenson 1987).

A site on Flathead Lake was recently chosen for the Mansfield Center for Pacific Affairs. The site is located on the west shore near Rollins at a location known as Painted Rocks. The Mansfield Center is to be a new international center for language, dialogue, and exchange, providing an enduring tribute to the public career of U.S. Ambassador to Japan Mike Mansfield. The center has been founded to respond to the need for an institution to strengthen America's economic, political, and cultural ties with the Pacific Basin in light of that area's growing importance in world economic activity and political influence. The development is envisioned as a residential conference complex, capable of accommodating 100 overnight guests, with an administrative office and small meeting rooms. The facility will have the design flexibility to host day-long conferences for 300 people, and the lake will provide an opportunity for swimming, fishing, and boating. At this time, the center is being designed and no date has been set for construction (Sorenson 1987).

Summary

Population growth rates in Flathead and Lake counties are currently about twice that of the state, but only about half the rate of the previous decade. Housing development in rural Flathead County appears to be stable at about 300 units per year; in Lake County, housing development has been decreasing over the last three years.

In both counties, new land divisions have been decreasing since 1980. Also, the majority of new land divisions are created without public review; in Flathead County, 80 percent of new lots and in Lake County 67 percent of new lots avoid subdivision review. One-half of the new subdivision plats in Lake County are lakefront or lakeview developments.

The major employer in Flathead County is the wood products industry and the major employer in Lake County is the agriculture industry. As with the nation and the state, these resource-based industries are very cyclical in nature and are currently in a low economic cycle. This may help explain the reduced rate of population growth between 1980 and 1985.

In both counties, tourism and retail trade are the strongest growing economic sectors. There are numerous new developments in Flathead County that are related to economic growth in the tourism sector. Much less of this type of development has occurred in Lake County.

Both counties have planning and sanitation programs that work to promote quality and appropriate growth and development. Flathead County has recently adopted an updated countywide land use plan; Lake County adopted a countywide land use plan in July 1988. Land use planning with citizen involvement established community goals for protection of valuable resources and enhancement of economic growth. For example, measures taken to protect water quality will enhance tourism and recreational development in the Flathead. Concern has been expressed by the Flathead Laker's organization and the Confederated Salish and Kootenai Tribes that the cumulative impact of land development around Flathead Lake may be affecting water quality. In light of this concern, the Flathead Basin Commission has supported research by the University of Montana Biological Station to conduct a sewage leachate study of the lake to identify areas of sewage breakout. This study is nearing completion and the results will be presented to the FBC this winter.

Flathead Basin Commission to Emphasize the Importance of Land Use Planning

The FBC recognizes good land use planning as a means of encouraging development while maintaining the basin's aquatic resources. Furthermore, the FBC recognizes that while both Flathead and Lake counties employ excellent planning staffs and the state-of-the-art land use planning is quite advanced, the acceptance of good planning by certain interest groups in the basin is low. Accordingly, the FBC will strive to draw attention to the need for good land use planning in the basin. This will be done by providing a public forum on the status of land use planning in the basin, publicly recognizing examples of good planning, and encouraging city and county officials to appoint talented, motivated individuals to planning boards.

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CHAPTER 6

Flathead Lake Levels

In recent years, the seasonal water level fluctuation of Flathead Lake has become a controversial issue fueled by competing interests such as hydroelectric power generation, flood control, farming, recreation, and fish and wildlife needs. Numerous meetings have been held and a great deal of correspondence has been exchanged to air all views and to attempt to reach solutions that are realistic and equitable to all parties.

Water levels in Flathead Lake are currently dictated by the operating regime outlined in a 1962 Memorandum of Understanding (MOU) between the Montana Power Company (MPC) and the U.S. Army Corps of Engineers. This agreement was developed and amended to satisfy the numerous interests in the Flathead area that are affected by the levels at which Flathead Lake is seasonally maintained.

A brief discussion of the history of this agreement, a summary of the issues, and some possible solutions to Flathead Lake level conflicts are provided below.

History

Kerr Dam, located on the Lower Flathead River about five miles below the outlet of Flathead Lake, was completed in 1938 and is owned and operated by MPC. Prior to the construction of this dam, Flathead Lake levels fluctuated naturally and were simply a function of input versus output. Spring runoff caused the water level to rise when water entered the lake more rapidly than it could escape through the outlet. Water levels peaked in early summer and then receded by mid-July or August (Hauer and Lorang 1987). Lake levels varied from year to year depending on the snowpack and the amount and timing of rainfall.

Today Flathead Lake levels are the result of a balance between the discharge patterns of Hungry Horse Dam, an upstream hydropower facility that partially regulates inflow, and Kerr Dam, which regulates outflow. The 1962 MOU between MPC and the U.S. Army Corps of Engineers set forth procedures for regulation of Flathead Lake in the interests of hydroelectric power generation and flood control. The MOU stipulated that the lake be drawn down to 2883' by April 15, and then be operated between 2883' and 2893'.

The MOU was amended by the Federal Power Commission in 1965 in an attempt to satisfy both lakeshore residents concerned about the recreation season, and farmers at the upper end of the lake who wished to keep lake levels down to prevent inundation of their fields by late spring floods. The amended agreement states that, conditions permitting, the lake will be drawn down to elevation 2883' by April 15, raised to 2890' by May 30, and to 2893' (full pool) by June 15. Although there are no formal provisions for a summer lake level, efforts are made to keep the level at or near 2893' from June 15 until late September.

Kerr Dam was relicensed by the Federal Energy Regulatory Commission (FERC) in 1985. A condition of that license was that MPC must discharge an instantaneous minimum flow of 3,200 cubic feet per second (cfs) immediately downstream from the powerhouse, where previously the minimum was 1,500 cfs average daily flow. This stipulation, along with the operation of the dam for load frequency control (to meet hourly shifts in demand for electricity) and operational constraints on Hungry Horse Dam, limits MPC's ability to make major changes in its current operating program.

The Issues

Fluctuating water levels in Flathead Lake affect a growing number of groups, activities, and resources in the Flathead area, including tourism, recreation, agriculture, power generation, flood control, and fish and wildlife. These and other issues are discussed in the following sections.

Marina Owners

In August 1986 Flathead Lake was about six inches lower than normal for that time of year, which adversely affected some marina owners by rendering certain docks inaccessible by boat. Marina owners generally believe the lake should be viewed as a major recreational attraction as well as an energy source, and that MPC should have more responsibility towards those who depend on the lake for their livelihood. The marina operators also suffer a significant loss of revenue when Memorial Day (which is now a floating holiday) occurs before May 30, when the lake is to be within three feet of full pool. They would like to see the MOU renegotiated to change the dates and water levels to benefit the tourism industry. They would also like to be notified in advance in the event of excessive drawdowns so that boats can be moved before they are grounded.

Area Farmers

Those who farm land in the lower Flathead Valley generally want the MOU to stand as is and oppose lengthening the tourist season by filling Flathead Lake earlier and keeping it higher longer. Filling the lake too early could cause significant flooding of their lands if late spring runoff is high, as occurred in 1964. In addition, if the lake is not drawn down in September, the land does not drain and is unworkable. They believe that some of the agricultural land would become marshland if the lake was artificially held at high levels longer.

Flood Control

The primary intent of the 1962 MOU was to control storage and releases from Flathead Lake for flood control. However, even with the drawdown schedule in place, the flood of 1964 (caused by heavy June rains) was costly and disastrous. Some who live on the Flathead River, and who witnessed the 1964 flood, do not wish to see an earlier refill schedule for the lake.

Higher lake levels earlier in the season combined with normal spring runoff in the Flathead River between Kalispell and the lake could raise river levels, increase bank erosion, increase flooding, and delay drainage of area farmland. Reduced lake storage would cause the lake to fill to higher levels during spring runoff and to discharge higher flows for a longer time. This could cause increased lake flooding and downstream river flooding during large runoff events, and higher outflows could cause Kerr Dam to spill and lose power production (Foster 1988).

Power Generation

The primary mission of the Kerr Dam Project is to provide electricity customers with the lowest cost service and commodity that is reasonable to provide in a safe, reliable, and environmentally compatible manner (Labrie 1986). Although MPC attempts to maintain lake levels that satisfy competing users, certain operational constraints can affect its flexibility in adjusting lake levels. The operation of the dam is linked to the Pacific Northwest Coordination Agreement that coordinates the operation of all hydropower projects in the region to optimize electric power generation. MPC must therefore be capable of responding to changes in regional energy demands in its operation of Kerr Dam.

Certain operating constraints were placed on the Bureau of Reclamation's (BOR) Hungry Horse Dam in 1981 under the Northwest Power Planning Council's (NWPPC) Fish and Wildlife Program. These included a 3,500 cfs minimum year-round discharge for rearing of resident fish species, a maximum discharge of 4,500

cfs from October 15 to December 15 for kokanee spawning, and limited releases on summer weekends to provide increased recreational opportunity on the river. Because Flathead Lake levels are partially controlled by operation of Hungry Horse Dam, these constraints can also affect MPC's ability to control the lake level.

As was mentioned previously, MPC is now required to maintain a continuous minimum outflow of 3,200 cfs downstream of the Kerr Dam powerhouse as a stipulation of the 1985 FERC relicensing procedure. Meeting that stipulation also reduces MPC's flexibility in controlling the level of Flathead Lake.

Fish and Wildlife

Fluctuating water levels in Flathead Lake affect the area's fish and wildlife resources. Any proposals to change the current operating regime would have to consider those impacts. For example, while filling Flathead Lake earlier in the year would benefit the Flathead Lake fishery, the resulting early drawdown in Hungry Horse Reservoir would damage the reservoir's trout fishery. Also, a rising lake level in April could inundate waterfowl nests.

The Confederated Salish and Kootenai Tribes, with funding from the Bonneville Power Administration (BPA) and MPC, have been studying the effects of Kerr Dam releases on fish and wildlife in the Flathead River below Kerr Dam and on lake levels in the south bay. A recent report (Cross and DosSantos 1988) outlines these impacts and possible mitigative strategies.

Another stipulation of the 1985 FERC relicensing of Kerr Dam calls for MPC to present a fish and wildlife plan to FERC by October 1, 1989. The conclusions in this report may affect the lake level fluctuations that may be permitted under the license. MPC has stated that every effort will be made to accommodate the wide range of interests in addressing the lake level issue.

Shoreline Erosion

The change in the hydrograph of Flathead Lake that resulted from the construction and operation of Kerr Dam has adversely affected shoreline erosion, particularly in the north shore area between Bigfork and Somers. Maintaining the lake near 2893' from June through September has resulted in the flooding of large areas of this north shore throughout the summer and has exposed these areas to a period of extended erosion. Almost two square kilometers of forest and meadow habitats have been modified or

eroded into the lake. This process has clearly had a major impact on the shoreline ecology of the lake (Hauer and Lorang 1987).

Any changes in the current operating regime of Kerr Dam would have to consider the possibility of increased erosion in susceptible shoreline areas of Flathead Lake.

Climatic Factors

Weather patterns are the one variable in the whole lake level discussion that is beyond regulation. No two years are alike in the timing and amount of inflow to Flathead Lake. Despite the best efforts to satisfy all competing interests, there will be years when climatic factors force all parties to shoulder some of the burden, whether it be in a flood or a drought year. For example, in 1986 a mid-winter thaw caused significant runoff. The snowpack in late May, however, was only 65 percent of normal, resulting in lower than usual spring runoff and lower inflow to the lake. This, along with other factors, translated into below-full-pool water levels in the lake late that summer.

The Solutions

The previous section clearly indicates that improved water level conditions in Flathead Lake cannot be accomplished without considering effects throughout the entire Flathead system. There is not likely a single solution that will satisfy all parties every year, but there are possible strategies that could be employed to try to address the concerns of those in the tourism industry. These are explored in the following sections.

Amendment of the MOU

Some lakeshore residents, particularly marina operators, advocate reopening the MOU and adjusting the lake level schedule for Flathead Lake. Ideally, they would like the lake to be sustained at full pool from May 1 to October 15. House Bill 453, passed by the 1987 Montana Legislature, designated the Montana Department of Commerce as ombudsman for the tourism industry and recreational interests in matters concerning the regulation of Flathead Lake levels. The Department has encouraged MPC to consider a renegotiation of the MOU to accommodate the floating Memorial Day holiday and low snowpack years.

While some modification of the spring refill schedule might be possible, particularly in very low snowpack years, detailed hydrologic, hydraulic, and hydroelectric investigations would be needed to determine the added flood risks in the event of above-average runoff. It is unlikely that a May 1 refill schedule would be implemented because site-specific hydrologic factors such as heavy rainstorms, thunderstorms, and abnormal temperatures during the snowmelt phase cannot be predicted with accuracy. A particular combination of conditions can turn minor runoff events into major floods. However, it might be possible to adjust the refill schedule each year according to when the Memorial Day holiday occurs, rather than the May 30 date stipulated in the agreement. Any changes to the MOU would have to consider all possible "side-effects", particularly with regard to flood control, agricultural productivity, fish and wildlife resources, power generation, and others.

Redesign of Facilities

A redesign of facilities to operate over a wider range of lake levels is one way to address the problem. For example, certain existing docks or boat launch ramps could be extended to reach deeper water, or new deep water launches could be created at strategic areas around the lake. While this type of work could be costly to the property owners, it may be one of the only ways to ensure a long-term solution.

Dredging

Another possible solution is to dredge around docks, creating deeper water for boat access. Although site-specific engineering proposals in the lake require a Section 404 permit, the Corps of Engineers has expressed a willingness to provide planning and design, and possibly financial assistance to commercial interests on the lake. The Corps feels that only a very small amount of dredging would be needed to make selected facilities usable at present lake level ranges (Foster 1988).

Public Notice of Drawdowns

Some of the marina operators have asked that they be notified in advance if MPC needs to drawdown excessive amounts of water to meet energy needs or to respond to emergency situations. This would allow the marina operators to move boats so that they are not affected by falling lake levels. It appears the MPC could easily provide such a public notice and this option should be pursued.

Conclusions

Seasonal water level fluctuations in Flathead Lake are an ongoing issue that may become even more critical given Montana's current drought pattern. The Montana Power Company is under considerable pressure to meet its own needs and those of other parties affected by the schedule and amount of lake level fluctuations. MPC feels the current MOU strikes a good balance among the competing interests, and believes the 2,890' level on May 30 and the target of full pool by June 15 are already significant concessions to recreation that have affected power generation at Kerr, decreased the flood control capability of the lake, and increased the threat of agricultural flooding above and below the lake (Gruel 1987).

It is hoped that the management plan required of MPC by FERC in the 1985 relicensing of Kerr Dam (due in October 1989) will address the full range of potential public/private concerns related to seasonal lake level fluctuations, and that the public will be involved in the formulation of this plan.

A cooperative effort will be required to resolve conflicts related to Flathead Lake levels. Each party must be willing to work to achieve the most equitable solution and also to share some of the burden. The bottom line is that Flathead Lake levels are partially dictated by climatic factors that are largely unpredictable and certainly uncontrollable, and this provides, at times, a difficult framework in which to operate.

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CHAPTER 7

New Studies and Initiatives in the Flathead Basin

The Flathead Basin is the subject of numerous environmental studies and economic development efforts. Some of these studies are summarized below. For more information on these or other Flathead area initiatives, contact the Flathead Basin Commission. The Commission's duties include supporting economic development without compromising the basin's aquatic systems.

Study of Shoreline Sewage Leachates in Flathead Lake

Concern over shoreline contamination from onsite sewage disposal systems along Flathead Lake has long been a concern. The Montana Department of Health and Environmental Sciences contracted with the University of Montana, Flathead Lake Biological Station in 1988 to study shoreline sewage leachates and their potential impact on Flathead Lake (Hauer 1988). Thirty-five sites were selected for further evaluation using field fluorometry and conductivity, or visual observations of high algal growth. Laboratory analysis of water samples taken from these sites indicated that 16 locations were very likely receiving septic leachates, and another four sites were possibly receiving sewage leachates. Five of these sites were in the Lakeside area, while the remainder were distributed elsewhere along the lakeshore.

A follow-up study employing tracer dyes would be necessary to define sources of contamination in those locations indicated in the study as likely to be receiving septic leachates.

Although no visible seeps were identified in the Woods Bay area, frequent accumulation of diatomateous algae offshore indicates that further study of this area may warranted.

Hydrogeologic Analysis of Septic System Nutrient Attenuation Efficiencies in the Evergreen Area, Flathead County, Montana

The Ground Water Pollution Control Program, DHES-Water Quality Bureau, contracted with the Montana Bureau of Mines and Geology (MBMG) to determine the nutrient removal efficiency of septic systems in the Evergreen area near Kalispell, and to characterize local aquifer parameters. Information obtained from this study is intended to assist in determining whether a sanitary sewer system is needed in Evergreen to reduce the loading of nutrients into the Flathead Valley hydrologic system.

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Two septic systems considered representative of household wastewater disposal systems in Evergreen were selected for study by the Flathead County Health Department and the MBMG. Lysimeters (soil moisture monitoring devices), tracer tests using lithium bromide, slug tests on individual wells, and a high capacity aquifer pump test were used to provide information in the study. In addition, phosphorus adsorption experiments and geochemical modelling of water chemistry data were included in the study.

The study concluded that both septic systems were actively contaminating the underlying groundwater with nitrate and phosphorus derived from septic effluent (King 1988). This confirmed that septic systems are contributing nutrients to the groundwater beneath Evergreen, and that nitrate levels in the area groundwater may be rising as a result. The large volume of groundwater flowing beneath the area, however, may be reducing the severity of groundwater quality problems through dilution. These results, however, have substantiated the concern that additional nutrients derived from septic systems will strengthen the overall nutrient load on the Flathead Valley hydrologic system, and may cause water quality problems for local users of groundwater in the future.

The Flathead Lakers' Resident Survey of Public Concerns and Priorities Relative to Flathead Lake

The University of Montana, Bureau of Business and Economic Research, at the request of the Flathead Lakers (a citizen organization composed mostly of lake-area residents and property owners), conducted a survey to determine area residents' concerns and priorities relative to Flathead Lake (Lenihan and Johnson 1987). The survey was conducted in July and August 1986, and involved questionnaires mailed to over 3000 persons who maintain residences in the area immediately surrounding Flathead Lake. In addition, 75 persons out of those who did not return completed questionnaires were surveyed by telephone. Survey participants were asked to rank five issues with respect to their preferred priority for the Lakers organization. These included public access issues, fishing-related issues, water quality, lakeshore development, and developing a closer working relationship with the Flathead Tribes.

The survey was completed and returned by 862 persons. The responses clearly identified water quality as the major public concern regarding Flathead Lake. Nearly 80 percent of those responding to the survey said that water quality should be the number one priority of the Flathead Lakers. Fishing and fishing-related issues, tribal relationships, and public access issues were of considerably less concern.

The majority of respondents named sewage from nearby urban areas and from lakeshore residences as the greatest threat to the lake's water quality.

Residents are also concerned about pollution from high-density residences, from the proposed Cabin Creek mine, and from the introduction of nonnative species into the lake. Few see changes in water level, upstream farming and logging, motor boats, or rain and snow as major threats to the lake's water quality.

Lakeshore residents would require towns on the Flathead River above the lake to improve their wastewater treatment plants. They would also support stricter rules for septic systems at lakeshore homes and for clearing forest lands, and they want continued monitoring of the lake water. A large majority said that they would support a ban on phosphate-containing detergents and cleaning products in Flathead and Lake counties (which was subsequently implemented in 1987).

The survey indicated solid support for two Flathead area institutions: the Flathead Basin Commission and the University of Montana Flathead Lake Biological Station. The question concerning the Flathead Basin Commission, however, resulted in the highest nonresponse rate, indicating a sizable portion of the lakeshore residents either are not familiar with the Commission, or have no opinion about it.

Fifty-nine percent of lakeshore residents said they live there year round; one-third said they are seasonal residents. Sixty-two percent of lakeshore residents said they are within the boundaries of the tribal reservation. Thirty-five percent said they live off the reservation.

Northwest Montana Human Resources, Inc. Water Quality Education Project

In 1987 a number of efforts were initiated to protect water resources in the Flathead Basin, to promote economic well being, and to encourage public participation in issues relating to clean water. Northwest Montana Human Resources, Inc. and the Flathead National Forest began to receive requests from socially and environmentally concerned organizations to provide video coverage of events and meetings that focused on water resources.

In response to these requests, a committee (called WATER) was formed in May 1987 to begin an organized approach to increase public awareness via the video medium. WATER's action plan called for the production of six documentaries designed to offer a clear, nonadvocacy presentation of water issues. Three of these documentaries, "The Science of Water," "The Uses of

Water," and "The Economics of Water" are near completion. Work on production of "The Jurisdiction of Water" is continuing. These 30-minute productions are suitable for presentation on commercial, cable access, and public television, as well as for use in schools, civic meetings, and other events.

The action plan also provides for video coverage of public meetings, workshops, symposiums, conferences, and other lectures conducted by various interest groups and public agencies with jurisdiction over water-related activities in the Flathead Basin.

Upper Flathead System Fisheries Management Plan: Montana Department of Fish, Wildlife and Parks, and the Confederated Salish and Kootenai Tribes

A draft Upper Flathead System Fisheries Management Plan was cooperatively prepared and released for public comment in 1988 (Montana Department of Fish, Wildlife and Parks and the Confederated Salish and Kootenai Tribes 1988). The management plan is intended to guide fisheries management within the Upper Flathead River System for the next five years (1989-1994). The plan covers Flathead Lake and its major tributaries, and contains a description of the Flathead watershed, system-wide fisheries management goals, species-specific fisheries information including alternative objectives and strategies, and fisheries management alternatives. A questionnaire on the public's opinion of the proposed plan is included with the report.

A final plan will be prepared and released in early 1989 following a review and evaluation of public comment on the draft plan. As more information becomes available about the Flathead system fishery, the agencies intend to evaluate and modify management programs as necessary and appropriate.

Flathead Economic Development Corporation

The Flathead Economic Development Corporation was established in 1988, following organizational efforts that began in 1986. The corporation provides informational materials explaining the Flathead Valley's advantages to firms considering a relocation or expansion to the area. In addition, businesses already in the area receive assistance in taking advantage of federal, state, and local financial and technical programs available to start-ups and expansions. The corporation also provides a full range of business counseling services, using its own staff resources and those of the Flathead Valley Community College (FVCC) and local private service providers. A work program is currently being designed to more fully coordinate the corporation and FVCC business assistance services to assure the most efficient utilization of both.

The Flathead Economic Development Corporation focuses its efforts on business retention, encouraging and supporting existing area businesses, rather than on recruitment of out-of-state firms.

City of Kalispell Community Development Activities

Since the start of redevelopment activities in 1979, the City of Kalispell Community Development Department has, through local redevelopment plans and organizations, completed several major redevelopment projects, including an $18 million retail mall and convention center complex, major public works activity, park expansion, economic development projects, off-street parking and land assemblage, commercial and residential rehabilitation, and economic development for Flathead Industries for the Handicapped.

Over the past several years, the scope of the redevelopment program has grown to include substantial interaction with the private sector. The local tax base has been significantly expanded, with the increase being set aside to generate more economic development activities.

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Montana Department of Fish, Wildlife and Parks and Confederated Salish and Kootenai Tribes. 1988. Draft upper Flathead system fisheries management plan, 1989-1994.

APPENDIX A

Flathead Basin Commission Meeting Summary: January 1986 - December 1988[1]

January 30, 1986 - Kalispell

- informational meeting on the proposed phosphorus detergent ban; speakers included: Steve Pilcher discussing the Department of Health and Environmental Science's phosphorus limitation strategy for Flathead Lake; Jack Stanford discussing the parameters of the lake's phosphorus problem; Representative Ben Cohen, sponsor of House Bill 711; Paul Horvatin discussing the EPA's experience with phosphorus detergent bans in other states; Richard Sedlack presenting the views of the Soap and Detergent Association; Dick Otis presenting an engineering alternative to a phosphorus detergent ban; testimony regarding a Flathead County detergent performance survey; and concerned citizens

March 27, 1986 - Pablo

- qualifications for Public Education Program Coordinator
- Pondera Hydro's dam proposal on the lower Flathead River
- Lee Carruthers efforts to develop a Flathead Economic Development Group
- Forest practices tour in the North Fork area on May 28th
- proposed Evergreen sewer: meetings, bond issue failure
- fishery studies in the upper and lower Flathead Basin (presentations by Dave Cross and John Fraley)
- Jack Stanford's proposed study on the cumulative water quality impacts of subdivisions around Flathead Lake (leachate study)

1 This summary includes topics of discussion and motions passed by the FBC.

- Flathead Lakers' letter calling for a moratorium on approval of new subdivisions around Flathead Lake

- Flathead Lakers' questionnaire on issues involving Flathead Lake

- state review of cumulative water quality impacts under the Montana Environmental Policy Act and the Montana Subdivision and Platting Act

- update on International Joint Commission's Cabin Creek mine study (presentation by Jim Posewitz of the Department of Fish, Wildlife and Parks)

- proposal by Mark III Incorporated to pump water from Greenacres slough near Kalispell (presentations by Dean Marquart and Steve Pilcher)

April 24, 1986 - Kalispell

- Public Education Program

- presentations by John Wilson and Carol Daly of the Montana Department of Commerce, and Dan Averill, a local businessman, on the economics and importance of tourism in the Flathead area

May 28, 1986 - Field Trip

- Forest Practices tour in the North Fork area of Flathead River (led by Ed Brannon and Gary Brown)

June 18, 1986 - Polson

- water quality master plan (contributions, report, USGS stream gauging)

- Commission passed a motion to provide the USGS with $2800 to pay the state's share of the annual costs of maintaining stream gauging stations on the Whitefish and Stillwater rivers

- need for a septic leachate study of Flathead Lake

- Evergreen sewage problems; bond issue failure, etc.

- Public Education Program; funding received, office space, slide show

- "ring around Flathead Lake", caused by dead algae; pending investigation by a Masters degree student at UM Biological Station (presentation by Jack Stanford)

September 16, 1986 - Evergreen (Kalispell)

- forum on Evergreen septic problems; speakers included: representatives of the Evergreen Water and Sewer District Board; the City of Kalispell; the Montana Water Quality Bureau; the Flathead City/County Health Department; the Flathead County Administrative Board; and local residents

October 14, 1986 - Polson

- Public Education Program
- USGS gauging stations
- Water Quality Monitoring Program: consortium funding, report
- FBC budget
- proposed December meeting with legislators
- FBC review of Resources Indemnity Trust Tax grant proposals for studies in the Flathead area
- Flathead Lake level issue (presentation by Pat Graham of DFWP)
- status of local option phosphorus ban
- report by Craig Hess on Lake Mary Ronan Forest Practices tour
- impacts of BPA budget cuts on the Northwest Power Planning Council's fish and wildlife mitigation plan

November 12, 1986 - Yellow Bay

- FBC budget; FBC passed a motion to seek a $10,000 increase in its general fund appropriations for the coming biennium. The need for this funding increase would be to help pay for surface water monitoring in Flathead Lake and its tributaries

- second biennial report
- water quality monitoring report (presentation by Jack Stanford)
- USGS stream gauging
- Public Education Program; Commission passed a motion that the Executive Director enter into a contract with the Freshwater Foundation in the amount of $15,000 to help pay the salaries of the Public Education Program. This funding was to come from the Commission's FY 86, 87, 88, and 89 biennial appropriations from the legislature; Commission passed a motion that the Executive Director, in cooperation with the Chairman, Vice Chairman, and other Commission members develop a plan to raise $15,000 to help pay the salaries of the Public Education Coordinator and Secretary for the second year of the Public Education Program. This plan is to be presented to Commission members by April 30, 1987
- Kerr Dam working committee: mitigation plan
- IJC Cabin Creek mine (presentation by Jim Posewitz)
- Flathead Land Trust (presentation by JoAnn Speelman)
- Proposed Biological Station sewage leachate study: water development grant application
- Evergreen groundwater study (presentations by Jack Stanford and Roger Noble)

December 1, 1986 - Bigfork

- evening meeting with legislators: discussion focused on Public Education Program, status of Flathead Lake's water quality, and the need for a Montana Forest Practices Act

February 19, 1987 - Kalispell

- Public Eduction Program
- biennial report
- budget before 50th legislature: FBC request for an additional $10,000 in general fund monies

- appointment of Ken Krueger to FBC to replace Henry Oldenburg
- IJC study of proposed Cabin Creek coal mine
- Kalispell Wastewater Treatment Plant tour
- NWPPC wildlife mitigation program for Montana (presentation by John Mundinger of DFWP)
- legislative issues:
    - HB 781 - Forest and Watershed Management Act - FBC passed a motion to send a letter to the Commissioner of State Lands endorsing the cumulative watershed effects cooperative the Forestry Division has been working on for the past three years and mentioning the FBC's strong interest in strengthening forest practices, particularly those that affect water quality and offering the FBC's cooperation as far as these efforts are concerned in the Flathead Basin
    - HB 746 - FBC passed a motion to support a bill establishing local governmental authority and responsibility for licensing septic systems
    - HB 599 - $321,000 appropriation to Yellow Bay Biological Station
    - HB 453 - authorizing the Dept. of Commerce to serve as an ombudsman for the tourism industry and recreationists in matters concerning the level of Flathead Lake
- concept paper regarding revisions to the Montana Subdivision and Platting Act

April 28 & 29, 1987 - Kalispell and Whitefish

- presentations by Ken Lustig, Environmental Health Director, Idaho Panhandle Health District. Mr. Lustig gave two breakfast seminars to community business leaders and a presentation to a joint meeting of planning and elected officials in Flathead and Lake counties

May 11 & 12, 1987 - Polson and Bigfork

- presentations by Bill Morgan, Regional Director, Tahoe Regional Planning Agency. Mr. Morgan gave two breakfast seminars to community business leaders and a presentation to a joint meeting of planning and elected officials in Flathead and Lake counties

June 5, 1987 - Glacier National Park

- establishment of FBC goals and priorities for the coming biennium (see Appendix C)
- election of officers

June 5, 1987 - Kalispell

- Tribal Fisheries Study (presentation by Dave Cross)
- MBMG study of individual septic tank impacts on the Evergreen aquifer; study prepared for WQB (Arrigo)
- Biological Station leachate study: paid for by DHES; final report due 6-1-88 (no completion report yet)
- Flathead Conservation District streambank inventory of Ashley Creek, paid for by DHES
- work plan priorities and chairman for each established, action plans called for
- fund raising for Public Education Program salaries
- Water Quality Monitoring Program: funding and report
- Flathead Lakers' annual meeting in April
- establishment of standing subcommittees
- new federal nonpoint source control legislation (presentation by Loren Bahls of DHES)

October 27, 1987 - Kalispell and Bigfork

- Public Education Program funding
- Evergreen sewer white paper
- Ashley Creek sewage treatment plant

- DFWP request to play a stronger role in FBC activities
- Public Education Program
- Water Quality Monitoring Program: costs
- effects of phosphorus detergent ban
- Biological Station lakeshore erosion study
- FBC priorities and action plans
- EQC forest practices study, FBC letter of support
- Flathead Area Cooperative Forest Practices Study
- Forum on land use planning in the Flathead Basin - evening meeting at Bigfork; speakers included: Thurman Trosper of the Lake County Planning Board; Steve Herbaly of the Flathead Regional Development Office; Jerry Sorenson of the Lake County Planning Office; Ed Gallagher, Director of Community Development for the City of Kalispell; and five panelists offering their perspectives on planning. Panelists included: Ric Smith; Nick Kaufman; Henry Ficken; Joan Toole; and Dan Averill

January 26, 1988 - Kalispell

- expanding the membership base of the FBC
- septic system permitting legislation
- Flathead Basin Cooperative Forest Practices, Water Quality, and Fisheries Program
- action plan assignments
- Public Education Program
- <u>FBC passed a motion</u> that a letter be sent to the Governor asking that the Executive Director be funded at a full time position next biennium
- proposed septic regulation rule changes in Flathead County
- update on Phosphorus Reduction Strategy (Big Sky Clearwater article); update on various elements of strategy (presentation by Steve Pilcher)
- Ashley Creek wastewater treatment plant

April 25 & 26, 1988 - Kalispell

- FBC Water Quality Conference entitled, "Our Clean Water - Flathead's Resource of the Future"

April 27, 1988 - Kalispell

- water conference debriefing, presentations by Christine Olsenius and Marty Jessen of the Freshwater Foundation
- Evergreen groundwater
- FBC structure
- appointment of additional subcommittees
- funding: FBC passed a motion to allow the Executive Director to enter into new contracts with the Freshwater Foundation to provide for a continuation of the Public Education Program staff services
- groundwater pollution in the Evergreen area (presentation by Lou Gates)
- update: Water Quality Monitoring plan (presentation by Jack Stanford)
- USGS stream gauging stations
- Flathead Lake level meeting at Bigfork (report by Steve Foster and Bob O'Leary)
- update: Flathead Basin Forest Practices, Water Quality, and Fisheries Program

June 14, 1988 - Polson

- funding
- discussion of the need to strengthen the FBC committee process
- Public Education Program
- IJC Cabin Creek mine study update (presentation by Jim Posewitz)
- change in membership structure: FBC passed a motion to seek public input regarding FBC proposal to expand FBC membership

- April conference followup, need for brochure to summarize where the FBC is focusing its efforts
- update: Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program grant application to support efforts submitted to DNRC
- presentation by Lee Carruthers regarding the Flathead Economic Development Corporation: video presentation
- Montana Rivers Study (presentation by Janet Decker-Hess of DFWP); FBC passed a motion to support the NWPPC's proposed rules for protected areas
- update on phosphorus detergent ban enforcement
- update on Evergreen sewer issue
- update of status of Ashley Creek sewage treatment plant improvements

August 3, 1988 - Kalispell

- proposal to expand the membership base
- Public Education Program
- Ashley Creek wastewater treatment plant
- Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program
- IJC Cabin Creek mine study report
- Jean Cumming to serve on Montana Water Resources Research Center Advisory Council

September 15, 1988 - Kalispell

- FBC passed a motion to seek legislation to expand the FBC's membership base
- discussion of proposed IJC testimony; FBC passed a motion opposing the development of the proposed Cabin Creek coal mine in British Columbia

December 6, 1988 - Columbia Falls and Kalispell

- Public Education Program breakfast seminar in Columbia Falls (presentation by Bob Herbst, Executive Director of Trout Unlimited)
- business meeting in Columbia Falls
- panel discussion on protecting the Flathead Tourism base; speakers included: Bill Martin, Chairman of the Flathead Visitors and Convention Bureau; Gil Lusk, Superintendent of Glacier National Park; and Bob Herbst

December 12, 1988 - Bigfork

- dinner meeting with Flathead area legislators

APPENDIX B-1

Flathead Basin Commission Financial Transactions Using General Fund Monies

July 1, 1985 - June 30, 1987

The 1985 Legislature appropriated $38,698 to the Commission for FY 86 and 87. This amount was later reduced to $38,138.

Key expenses during the biennium were the Executive Director's compensation and contracted services. Contracted services included: monies paid to the Freshwater Foundation, who in turn paid for the compensation of the public education coordinator and secretary in the Kalispell office; monies paid to the U.S. Geological Survey for the state's share of the annual cost of maintaining stream gauging stations on the Whitefish and Stillwater rivers; and monies paid to complete the first biennial report.

Executive Director Compensation		$19,558.04
Contracted Services		
Freshwater Foundation	$11,000.00	
U.S. Geological Survey	2,800.00	
S. Courtnage and DNRC (biennial report)	790.30	
Misc. Publication & Printing	487.59	15,077.89
Communications		
Postage	149.42	
Advertising (Kalispell staff positions)	229.64	379.06
Supplies and Materials		144.88
Meeting Room Rental		125.00
Subscriptions		11.35
Total Expenditure For Biennium		**$35,296.22**

APPENDIX B-2

Flathead Basin Commission Financial Transactions Using General Fund Monies

July 1, 1987 - June 30, 1988

The 1987 Legislature appropriated $19,845 to the FBC for FY 88. Key expenditures during this fiscal year were the Executive Director's compensation and contracted services. Contracted services included monies paid to the Freshwater Foundation, who in turn paid for the compensation of the public education coordinator and secretary in the Kalispell office.

Executive Director Compensation		$9,845.12
Contracted Services		
Freshwater Foundation	$4,000.00	
Misc. Publication & Printing	238.95	4,238.95
Communications		
Postage & Mailing	129.90	
Advertising	33.00	162.90
Meeting Room Rental		100.00
Registration Fee for Training Conf. Public Education Coordinator		165.00
Total Expenditure for FY 88		**$14,511.97**

APPENDIX B-3

Flathead Basin Commission Financial Transactions Using General Fund Monies

July 1, 1988 - June 30, 1989

The 1987 Legislature appropriated $19,845.00 to the FBC for FY 89. Key expenditures during this fiscal year are anticipated to be the Executive Director's compensation and contracted services.

Actual Expenditures to Date

July 1, 1988 - October 31, 1988

Executive Director Compensation	$2,675.08
Travel and Per Diem for Citizen Members	142.69
Actual Expenditures through 10/31/88	**$2,817.77**

Anticipated Expenditures for Remainder of FY 89

November 1, 1988 - June 30, 1989

Executive Director Compensation		$ 7,160.73
Contracted Services:		
Freshwater Foundation	$2,000.00	
Printing & Graphics - (Biennial Report)	4,000.00	
Other Contracted Services	2,500.00	8,500.00
Communications		200.00
Supplies and Materials		200.00
Meeting Room Rental		100.00
Miscellaneous Expenses		866.50
Proposed Expenditures 11/1/88 - 6/30/89		**$17,027.23**

APPENDIX B-4

Flathead Basin Commission/Freshwater Foundation

Public Education Program Sources of Funding[1]

Grant from Northwest Area Foundation[2]	$ 99,472
Flathead County[3]	7,500
U.S. Army Corp of Engineers[4]	3,800
Flathead Basin Commission (general fund monies)[5]	17,000
Confederated Salish and Kootenai Tribes[5]	5,000
Montana Dept. of State Lands[5]	5,000
Flathead National Forest[5]	2,000
Flathead Lakers[5]	1,000
TOTAL	$140,772

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1 This table shows the sources of Public Education Program funding from October 1986 to June 1989. (The balance remaining as of 11/1/88 is approximately $20,475.) 75-7-305 MCA allows the FBC to receive and expend, as statutory appropriations, donations, gifts, grants, and other monies necessary to fulfill its duties.

2 Grant went to the Freshwater Foundation, who in turn provided a portion of these monies to the FBC to implement the program.

3 In kind contribution of office space by Flathead County. Dollar amount estimated at $250/month X 30 months.

4 In kind contribution for the printing of the April 1988 Water Conference Proceedings.

5 The FBC's agreement with the Freshwater Foundation requires that $30,000 in compensation for the public education coordinator and secretary be secured from other sources in the basin. These five organizations represent those who contributed these monies. In July 1988 the Public Education Coordinator changed from a contract employee of the Freshwater Foundation to a full-time member of the Governor's Staff.

APPENDIX B-5

Freshwater Foundation
Flathead Basin Public Education Program
Budget Review - August 1, 1988

Northwest Area Foundation Grant #86-0017

Total Grant			$99,472
<u>Year 1 Expenditures</u>		$61,859 (Budgeted)	
Education Staff Salaries	$21,367		
Travel (Foundation and Education Coordinator)	5,033		
Postage	1,353		
Supplies	827		
Telephone	1,303		
Printing	827		
Equipment			
Slide Show	2,915		
Business Seminars	2,297		
Public Service Announcement	491		
Brochures - Printing Design	3,000		
Writing & Develop.	4,000		
Foundation Adm. Services	6,000		
		50,508 (Actual)	
<u>Year 2 Expenditures</u>		37,613 (Budgeted)	
Travel (Foundation)	933		
Postage	1,855		
Supplies	681		
Telephone	1,263		
Printing	2,353		
Miscellaneous	517		
PSA	786		
Conference	5,256		
Foundation Adm. Services	8,000		
		21,644	
Total Expenditures			72,152
Balance		27,320[1]	
State of Montana Funds (to date)[2]			26,000
Year 2 Education Staff Salaries & Travel		18,733	
Balance		$ 7,267	

1 The uses for these funds include: the development of two PSAs, and one business seminar between 8/31/88 and 5/30/89.

2 The FBC's agreement with the Freshwater Foundation requires that for the second year of the program, $30,000 in compensation for the Public Education Coordinator and Secretary be secured from other sources in the state (see Appendix B-4).

A P P E N D I X   B - 6

Flathead Basin Commission and Freshwater Foundation
Estimated Remaining Public Education Program Costs

October 1, 1988 - May 31, 1989

Public Service Announcements		
Lake Awareness with Jack Stanford	$ 320	
Groundwater	1,000	$ 1,320
Columbia Falls Breakfast Seminar		1,400
Brochures		
Land Use Planning (in preparation)	3,000	
Nonpoint Source Pollution	3,000	
Economics of Clean Water	3,000	9,000
Conference Proceedings - Distribution & Marketing		350
Kalispell Office/Secretarial Expenses (10/1/88 - 5/3/89)		
Seven Months Sec. @ $600/mo.	4,200	
Seven Months Office @ $435/mo.	3,045	7,245
Foundation Administrative Expenses		5,000
Other Expenses		1,400
Total Estimated Program Costs		**$25,715**
Less Sale 60 Brochures @ $10 Each		**$25,115**

APPENDIX B-7

Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program

Anticipated Sources of Funding[1]

	CY 1988	CY 1989	CY 1990
Flathead Natl. Forest	$30,000[1]	$50,000[2]	$50,000[2]
State of Montana, Renewable Resource Development Grant	-0-	$25,000[3]	$25,000[4]
Plum Creek Timber Co., Inc.	$10,000	$20,000	$20,000

1 The Flathead Basin Commission (FBC) is coordinating the expenditure of the funding necessary for the operation of this cooperative program (see Chapter 3). As of December 2, 1988, $10,000 of the funding listed in this table had been received by the FBC. 75-7-305 MCA allows the FBC to reserve and expend donations, gifts, grants, and other monies necessary to fulfill it duties. Such monies are statutorily appropriated as provided in 75-7-502 MCA.

2 Contingent upon Congressional budget authorization and administrative allocation.

3 Applied for through 1989 Legislature.

4 Estimated from other State of Montana sources.

APPENDIX C

Flathead Basin Commission Priorities for the 1987 - 1989 Biennium

Established July 10, 1987

Public Education Program

The Flathead Basin Commission (FBC), with financial and technical assistance from the Freshwater Foundation, has embarked on a two-year program to improve public understanding and support for clean water issues. This program includes the employment of a coordinator and a secretary to staff a Kalispell office. Outputs include audio/visual presentations, brochures, and public service announcements. The program also includes a series of breakfast seminars and a two-day symposium.

FBC members and the Public Education Coordinator speak before civic, educational, and other groups on issues involving clean water and economic development. Speakers are encouraged to use the slide show and other audio/visual materials.

Providing a regional forum for the discussion of water quality and related issues is one of the FBC's primary responsibilities. Another major responsibility is to serve as a credible information source and information synthesizer.

In the spring of 1988, the FBC will host a two-day symposium addressing maintenance of the basin's water quality. "Our Water-Our Future" is the theme that is central to this public education effort. Hence, the symposium will emphasize the responsibilities of all basin citizens, interest groups, and elected officials. A successful symposium will require that basin residents are not mere listeners, but are actively involved in the symposium.

Maintaining or improving water quality in the basin will be expensive and may, occasionally, require enforcement actions to bring businesses, homeowners, and municipalities into compliance. To counteract such negative aspects, the FBC will initiate a program for recognizing superior examples of good environmental stewardship. The intent of the program is to positively reinforce those who implement superior design, planning, and maintenance actions, and to draw public attention to such actions.

Funding

The FBC has a general fund budget of approximately $40,000 per biennium. This pays for a portion of the Executive Director's salary, for the biennial report, for administrative costs, and for special projects such as the water quality monitoring program.

The FBC wishes to establish a more permanent, as well as increased budget, so as to be able to devote additional efforts toward its mandated activities. An immediate need is to obtain the funding necessary to retain the public education coordinator and secretary through the FBC's second year of the Public Education Program. Other needs include compensation for anticipated shortfalls in the water quality monitoring program and the funding of specific water quality research. In addition, the FBC would like to fund its Executive Director at a level that allows this individual to devote full time to FBC business.

The Flathead Biological Station both participates in and coordinates an interagency water quality monitoring program for the FBC The total annual cost for the monitoring program by all participants is approximately $225,000. Funding of the Biological Station monitoring responsibility is provided by a six-member "consortium" including Flathead and Lake County governments, the Montana Power Company, the DHES-Water Quality Bureau, the Confederated Salish and Kootenai Tribes, and "in-kind" services by the Biological Station. Consortium funding and the interagency monitoring conducted by other participants, however, have been jeopardized by shrinking budgets.

The FBC places a top priority on adequate and effective funding for the monitoring program. It will strongly encourage contribution to the program by agencies, private interests, and the FBC itself.

Agenda 2000

The FBC's statutory responsibility is to preserve the quality of the basin's aquatic resources and to promote growth in the basin that is consistent with the maintenance of water quality. The FBC wishes to establish a series of specific goals that it believes are necessary if such responsibilities are to be met, and then develop action plans to meet such goals.

Broaden the Commission's Membership Base

Three of the seventeen members of the FBC (including ex-officio members and liaisons) are appointed to represent industrial, environmental, and other groups in the basin. One member must be the holder of a license issued for the Flathead Project under the Federal Power Act. The remaining 13 members are employees of federal, state, local, tribal, or provincial governments. The FBC believes it can become more effective if participation in FBC business were expanded to include a greater number of the basin's citizens. The FBC intends to present a proposal to the 51st Legislature regarding the addition of new members.

Encourage Construction of Municipal Wastewater Treatment Plants

Properly functioning wastewater treatment plants can significantly reduce the inputs of phosphorus and other pollutants into Flathead Lake. Furthermore, a major water quality problem in the basin is the existence of unsewered communities, such as the Evergreen area near Kalispell, where large numbers of the residents use improperly functioning septic systems, thus contributing to groundwater and surface water contamination. The FBC's policy on wastewater treatment plants (WWTPs) is as follows:

- We encourage the construction of new WWTPs to serve those areas in the basin where centralized sewage treatment is feasible.
- For new or existing WWTPs in the basin that discharge into state waters, we support the requirement of a 1 mg/l phosphorus standard for the effluent.
- Proper operation and function of WWTPs is critical if wastewater improvement specified in the WWTP's design is to be met.

The FBC's role regarding the Evergreen area shall be to:

- Provide effective information transfer.
- Present sewer construction alternatives to the public including comparative costs, (i.e., phased construction, linkage to Kalispell existing plant, a new plan solely for the Evergreen area, plant design alternatives, etc.).

- Work with area residents, their elected representatives, and the DHES-Water Quality Bureau to raise the local funds necessary for sewer construction.

Development of a Legislative Agenda Prior to the 1989 Session

A statutory responsibility of the FBC is to recommend legislation that would help preserve the basin's water quality. The FBC intends to develop a listing of proposed legislation by June 30, 1988, relevant to the FBC's responsibility. It is the FBC's intent that these proposals be introduced in the 1989 Session. The FBC will seek public input while developing such legislation and will publicly discuss proposed legislation at a specified FBC meeting. Lastly, FBC members will meet both individually and as a group with basin legislators to discuss proposed legislation.

Balance Economic Development with the Maintenance of Water Quality

Promoting economic development that is consistent with the maintenance of water quality is a statutory responsibility of the FBC To date, the FBC has emphasized solutions to the basin's water quality problems while spending comparatively little time on the economic development issue. During the 1987-1989 biennium, the FBC wants to place more emphasis on its economic development responsibilities. Possibilities include:

- Sponsoring efforts that encourage "clean" industry to locate in the basin.
- Establishing stronger contacts with the Chambers of Commerce, economic development authorities, utilities, and other groups' economic development efforts.
- Sponsoring research that identifies the value of the basin's water and the "opportunity costs" should such quality deteriorate. The FBC also wants to provide public recognition of water quality protection efforts by local business groups, individuals, etc.

Seek Full Implementation of the Phosphorus Reduction Strategy for Flathead Lake

Flathead Lake is threatened by both point source and nonpoint source water pollutants. In 1984 the DHES-Water Quality Bureau prepared a six-part strategy to reduce phosphorus, one of the most serious of these contaminants. The FBC endorses the DHES-Water Quality Bureau's phosphorus reduction strategy and has, in recent years, been active in helping implement three of the elements (1 mg/l effluent standard for phosphorus, the phosphorus detergent ban, and the development of new sewer systems).

The majority of the phosphorus reduction emphasis has, to date, been on implementing the point source aspects of the strategy such as the 1 mg/l standard for phosphorus in wastewater treatment plant effluent. The FBC finds nonpoint source contributors such as homesite development around lakeshores, failing septic systems, and forest runoff to be of equal importance. Thus, during the coming biennium, the FBC will focus additional attention on nonpoint sources of lake pollution.

The FBC recognizes that failed or failing septic systems are an important source of groundwater and surface water contamination in the basin. Furthermore, the FBC recognizes that state and county health departments lack adequate regulatory authority and staff to compel owners of individual systems to: 1) properly maintain their system, 2) replace failed systems, or 3) switch to alternative forms of wastewater treatment where individual systems are inappropriate due to soils, level of water table, etc. In recognition of this problem, the FBC will work closely with county sanitarians and the DHES-Water Quality Bureau to identify ways to strengthen existing authority so as to achieve the long-term goal of significantly decreasing the number of failed or failing systems in the basin.

The FBC recognizes that it is neither practical, nor feasible for both complete and simultaneous implementation of all six elements of the phosphorus reduction strategy. It does not believe, however, that any element of implementation should be delayed. The FBC will monitor and provide updates for the public on progress and the results of implementing the phosphorus reduction strategy.

Focus Public Attention on Good Land Use Plans

The FBC recognizes good land use planning as a means of encouraging development while maintaining the basin's aquatic resources. Furthermore, the FBC recognizes that while both Flathead and Lake counties employ excellent planning staffs and that the state-of-the-art of land use planning is quite advanced, the acceptance of good planning by certain interest groups in the basin is low. Accordingly, over the next two years, the FBC will strive to draw attention to the need for good land use planning in the basin. This will be done by providing a public forum on the status of land use planning in the basin, publicly recognizing examples of good planning, and encouraging city and county officials to appoint talented, motivated individuals to planning boards.

Encourage the Appointment of Qualified People to Boards, etc.

The FBC recognizes the important decision-making role of health, planning, sewer, and other citizen boards. The ability to make responsible decisions is dependent upon the knowledge, talent, dedication, and leadership of the board members. Accordingly, the FBC encourages elected officials to carefully consider who they appoint to citizen boards and to seek the advice of organizations such as the FBC before making appointments. Likewise, the FBC encourages qualified individuals to seek positions on citizen boards.

Effective Implementation of the River Basin Monitoring Program

The FBC has sponsored an interagency monitoring program for the Flathead Basin with the objective of providing data and trend analysis regarding water quality and fisheries. Currently, there are 12 agencies or corporations that contribute to this effort. In order for the data from all cooperators to be comparable and integrated into one monitoring report, the data collected must be consistent and must be analyzed using similar methodologies. The FBC will work with all cooperating agencies to see that such goals are met. Monitoring results will be published periodically by the FBC.

APPENDIX D

Memorandum of Understanding Regarding the Flathead Basin Forest Practices, Water Quality, and Fisheries Cooperative Program

July 1988

This MEMORANDUM OF UNDERSTANDING is made and entered into by and among the Flathead Basin Commission, hereinafter referred to as FBC; Montana Department of State Lands, hereinafter referred to as DSL; Plum Creek Timber Company, Inc., hereinafter referred to as PCTCI; Flathead National Forest, hereinafter referred to as FNF; Montana Department of Health and Environmental Sciences, hereinafter referred to as DHES; Montana Department of Fish, Wildlife and Parks, hereinafter referred to as DFWP; and the University of Montana, hereinafter referred to as UM.

* * * * *

In the Flathead Basin, one-third of the watershed is composed of forested lands which are managed for commercial forest production by FNF, DSL, PCTCI, and other entities. Valuable commodities are produced that substantially contribute to the regional economic base.

Flathead Lake and its tributary streams and rivers host water quality and a fishery of superlative quality which offers a valuable economic and recreational resource.

The effects of certain forestry activities (e.g., logging and associated road construction) may be a potential risk to the aquatic environment. At this time, the cause-and-effect relationship of specific forest practices on water quality and fisheries is not known.

WHEREAS, FBC is a legislatively created body to address the Flathead Basin's aquatic environment, the waters that flow into or out of Flathead Lake, and other resources of the basin; and

WHEREAS, DSL and FNF are government agencies that manage commercial forest lands within the Flathead Basin, and

WHEREAS, PCTCI is a private enterprise which owns and manages commercial timberlands; and

WHEREAS, DHES is charged with enforcing the laws governing water quality in the State of Montana; and

WHEREAS, DFWP is charged with managing the fisheries resource of Montana; and

WHEREAS, UM is an institution of higher education providing teaching, research, and service for the benefit of Montana citizens resources,

THEREFORE, in consideration of the above, the parties agree to create and participate in the FLATHEAD BASIN FOREST PRACTICES, WATER QUALITY, AND FISHERIES COOPERATIVE PROGRAM, dated July 1988, hereinafter known as the Cooperative Program, as follows:

1. To fulfill the Specific Objectives of the Cooperative Program, which are to document, evaluate, and monitor whether forest practices affect water quality and fisheries within the Flathead Basin, and to establish a process to utilize this information, if detrimental impacts exist, to develop criteria and administrative procedures for protecting water quality and fisheries.

2. To follow the Purpose of the Cooperative Program, which is to improve the management of Flathead area forested watersheds through the development and application of state-of-the-art information to prevent or mitigate the potential adverse effects of forest practices on water quality and fisheries.

3. To work closely and cooperatively as the Coordinating Team of the Cooperative Program to review and approve study elements so that the entire Cooperative Program forms a coherent package of studies and monitoring directed at learning if and how forestry activities affect fisheries and water quality.

4. To work closely as the Coordinating Team with the FBC on the logistics of the studies, funding, and public participation.

5. Agree to reach decisions within the Coordinating Team by consensus.

6. The Coordinating Team will serve to review progress, offer suggestions, and facilitate appropriate assistance from resource specialists from the various organizations involved in timber management and oversight in the Flathead Basin.

7. The participants of the Cooperative Program will provide staff support, technical expertise, funding, and/or other in-kind assistance. The FNF, State of Montana, and PCTCI tentatively will make the following funds available to finance administrative studies:

	CY 1988	CY 1989	CY 1990
Flathead National Forest	$30,000	$50,000	$50,000
State of Montana Renewable Resource Development Grant	-0-	25,000[1]	25,000[2]
Plum Creek Timber Co., Inc.	10,000	20,000	20,000

1 applied for
2 estimated from other State of Montana sources

The indicated funds will be made available and are the maximum amount that each source will contribute in any one calendar year. The funds will not be considered obligated until the necessary procurement documents are completed.[3]

8. Study leaders of individual study modules will prepare annual work plans to be approved by the Coordinating Team, but will otherwise operate independently of the Coordinating Team.

9. Progress of study modules will be reviewed by the Coordinating Team through annual work plans and semi-annual progress reports by the Study Leaders to the Coordinating Team.

10. This agreement shall become effective on the date of the last signature and continue for a period of three years from this date.

11. This agreement may be amended at any time with sixty (60) days notice to the other parties. Amendments will require signatory approval by all the parties involved. Termination can be initiated by any one party.

* * * * *

3 Nothing herein shall be construed as obligating the Forest Service to expend or as involving the United States in any contract or other obligation for the future payment of money in excess of appropriations authorized by law and administratively allocated for this work.

This MEMORANDUM OF UNDERSTANDING is agreed to by:

Executive Director Flathead Basin Commission	8/9/88 Date
State Forester Department of State Lands	8/8/88 Date
Director of Operations Plum Creek Timber Company, Inc.	8/8/88 Date
Supervisor Flathead National Forest	8/8/88 Date
Director Department of Health and Environmental Sciences	8/9/88 Date
Supervisor Region One Department of Fish, Wildlife & Parks	8/29/88 Date
Vice President for Research University of Montana	8/8/88 Date

APPENDIX E

Summary and Conclusions
Flathead River International Study Board's
Report to the International Joint Commission

Background

The following is a brief outline of the background for the Flathead River International Study Board's report and a summary of its conclusions. No attempt has been made, however, to summarize the baseline component of the study.

In February 1984 the British Columbia government granted Sage Creek Coal Limited approval-in-principle for a 2.2 million tonnes (2.4 million U.S. tons) per year thermal coal mine located 10 km (6 miles) upstream from the International Boundary on Howell and Cabin creeks, tributaries to the Flathead River. The mine plan is based on 21 years of mining at this rate. Coal reserves, however, exist for another 20 years of mining at the same rate. The Board has not assessed the potential impacts of extending the life of the mine.

The United States and Montana governments were concerned about the possible effects of this proposed mine on the Flathead River system, Glacier National Park, and Flathead Lake in Montana. The centerline of the North Fork of the Flathead River, from the International Boundary to the confluence with the Middle Fork of the Flathead River, is the western border of Glacier National Park. In addition, the park has been designated as a Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and has been nominated as a World Heritage Site. The North Fork of the Flathead River has been designated as a component of the U.S. National Wild and Scenic River system. Montana has classified the water quality of the North Fork of the Flathead River as Class A-1, the state's highest water quality classification, and has also established a nondegradation standard for these waters.

In response to these concerns, the United States and Canadian governments requested that the International Joint Commission examine the possible impacts of the proposed mine on water quality and quantity, fisheries, and water uses of the Flathead River at the International Boundary and downstream through Flathead Lake. The Flathead River International Study Board was established to undertake this investigation and to report its findings to the FBC.

The Board appointed four technical committees, a special subcommittee, and a task force to describe the existing environmental conditions and water uses in the study area, and to assess the potential changes to those conditions that could arise as a consequence of the development, operation, and reclamation of the proposed mine. These groups were the Mine Development Committee (MDC), the Water Quality and Quantity Committee (WQQC), the Biological Resources Committee (BRC), the Water Users Committee (WUC), the Water Quality Criteria Subcommittee (WQCSC), and the Limnology Task Force (LTF).

The Board was requested in its terms of reference to use existing information, or any that might become available during the analysis. For the proposed mine, the Board was to base its assessment on the current proposal with the conditions attached as part of its approval-in-principle.

The Board encountered two major problems in meeting the terms of reference established by the FBC. First, the mine plan is only at a conceptual level of design. This level of design (called Stage II) is generally adequate to consider approval-in-principle under British Columbia's Mine Development Review Process, but is not adequate to develop reliable, quantitative predictions of impacts on water quantity, water quality, or biological resources at the mine site or at the International Boundary. A more detailed level or design (called Stage III), required before specific permits and licenses can be granted by the British Columbia (B.C.) government's regulatory agencies, would be necessary before predictions of many of these impacts can be made with confidence. Second, the baseline data required to assess the impacts of the proposed mine are generally not adequate; thus the Board and its technical committees often had to use professional judgement when developing conclusions, rather than basing them on data.

As a framework for assessment by the committees, the Board developed two cases for mine site operation to provide a range of discharges and possible impacts. The "optimal" case was considered to represent the most desirable situation, whereby the mine would employ state-of-the-art environmental control technology and would operate in compliance with all legislative and regulatory requirements. To accomplish this, it is assumed that certain mitigative measures would be applied that generally have not been required at other operating mines. The "adverse" case represented operating conditions where, despite the use of the best practical technology, there would be occasional failures to meet specified requirements. The Board notes that both of these operating cases assumed adherence to the Stage II design. The Board used information from existing mines in the Elk River Basin to develop this adverse case, but cautions that transferring these data is difficult, in part because the

environmental control technology at the proposed mine will be different from that at the existing mines.

The BRC, however, based on its interpretation of current coal mining practices in southeast B.C. and its observation that strict adherence to Stage II mine plans is without precedent in British Columbia, defined its optimal and adverse cases differently from the Board. Consequently, the BRC's impact assessment does not represent the same range of conditions as that developed by the MDC and used by WQQC. While this redefinition of the Stage II mine plan created a problem for the Board in its own assessment, it did demonstrate that environmental concerns must receive special attention if either the Board's optimal or adverse conditions are to be achieved.

Conclusions

Water Quantity

The Committees and the Board were unable to distinguish between the optimal and adverse cases in assessing changes in water quantity. The Board concludes that the mine will not have significant effects on water quantity at the International Boundary in either case.

The effects of the mine on Cabin and Howell creeks at and immediately downstream of the mine site are difficult to predict because of the complex interrelationships between surface water and groundwater hydrology. In the premining phase, there is a potential for increased flow in these creeks during freshet due to land clearing, and reduced flows during baseflow periods due to decreased groundwater discharge. During the early phases of mining, net flows in these creeks are expected to change less than 10 percent due to the counterbalancing of increases from groundwater infiltration and decreases in surface flows due to diversion into the Flathead River. In the late stages of mining, once the pits extend below the valley floor, there is a possibility of reversals in groundwater flows resulting in loss of water from Howell and Cabin creeks to the pits. The probability and the magnitude of this loss is unknown because of the present poor understanding of the groundwater regime.

Stream Morphology

No significant changes are expected to the morphology of Cabin and Howell creeks if, as proposed in the Stage II report, the extent of riprapping is limited, and if the streams are allowed to meander within the largely unaltered buffer strip. The B.C. government has stipulated that a 90-m wide, undisturbed buffer strip is to be maintained along the banks of Howell and Cabin creeks as a condition for the development of this mine. The Board notes, however, that this level of protection is unprecedented at coal mines operating in B.C.

Water Quality

Sedimentation. The Board concludes that there will be increased sedimentation due to the mine. Under the optimal case, the increase in sediment loads and concentrations at the International Boundary would be insignificant. Under the adverse case, the maximum increases in loads and concentrations at the International Boundary would be on the order of five percent due to sediment yields from the mine site. Little information exists to quantify sediment yields from nonpoint sources beyond the mine site, such as the proposed haul road to Morrissey and the power line corridor.

The Board concludes that at the mine site, under the adverse case, sediment will be generated during the premining and land-clearing phase and that some of this sediment will be deposited in the creeks. During the mining phase, during freshet and in summer storms (averaging four occasions per year), increased suspended sediment concentrations in Howell and Cabin creeks will exceed the ambient objectives set by the B.C. government of 10 milligrams per liter (mg/l) increase above background and the WQCSC no-effect level (NEL) criteria for maximum instantaneous concentrations. Under the optimal case the increases in suspended sediment concentrations will not exceed the B.C. objectives, but may exceed the WQCSC NEL criteria at times.

Generally, the Board believes that in both the adverse and optimal cases, most of the additional fine sediment will be flushed out of Cabin and Howell creeks during freshet. There will be some deposition of fine sediments in stream gravels in areas of lower than average stream velocity and also in the late stages of freshet. There will be some deposition of fine sediments in stream gravels in areas of lower than average stream velocity and also in the late stages of freshets. Some of this sediment may persist for some time and may exceed the WQCSC NEL criteria for deposited sediments.

Turbidity. The Board concludes that there will be an increase in turbidity associated with the increase in suspended sediment concentrations. Under the optimal case, changes in turbidity would not be visible at the International Boundary. In the adverse case the minimum increase in turbidity at the International Boundary is expected to be about 10 percent. This would occur typically during freshet and during summer and fall rain-storms when sediment concentrations, and hence turbidity, are already high. The Board has been unable to determine whether such an increase in turbidity would be visible.

Temperature. Changes is surface water temperatures at the International Boundary are not expected to be significant under either the adverse or optimal operating cases. Under the optimal case, the temperature change in Howell and Cabin creeks is expected to be between -1°C and +1°C (-1.8°F). Under the adverse operating case, temperature changes of -2°C to +3°C (-3.6°F to +5.4°F), are possible depending on the amount of groundwater upwelling into these creeks, the timing and location of pond discharges, and the possible loss of surface water to the pits. These changes would exceed the B.C. objectives of ±1°C (±1.8°F), and the WQCSC specific criteria for temperature.

Nutrients and Toxic Compounds of Nitrogen. The Board is primarily concerned with increases in phosphorus (P) and nitrogen (N) in their various chemical forms, notably biologically available phosphorus (BAP), nitrate, and the toxic forms ammonia and nitrite. It concludes that even under the adverse operating case, total BAP loading to Flathead Lake would increase by less than 1 percent and thus would not contribute measurably to eutrophication (enrichment) of the lake.

Based on existing information, the Board is unable to determine whether the increase in P concentrations at Howell Creek will exceed the B.C. objectives of the WQCSC NEL criteria for soluble reactive phosphorus (SRP), for either the optimal or adverse cases, because it is not known where the material will enter the creeks. These objectives and NEL criteria will likely be exceeded at the International Boundary under either case because of the zero-increase objective for receiving waters. For Howell Creek and the Flathead River at the International Boundary, under both the optimal and adverse cases, the predicted increase in N will exceed substantially the WQCSC NEL criteria, but not the B.C. objectives.

The Board feels that there will be significant increases in nitrite and ammonia concentrations in Cabin and Howell creeks due to blasting residues that contain large amounts of nitrates. The Board concludes that, to the extent that there is a groundwater connection between sources of nitrite and ammonia and the

streams, concentrations of these compounds would exceed the B.C. objectives and the WQCSC NEL criteria, resulting in toxic levels in the spawning areas in Howell and Cabin creeks under both the optimal and adverse cases. The Board also concludes that the nitrite and ammonia will probably be oxidized to non-toxic nitrate before reaching the International Boundary.

Other Water Quality Parameters. The Board also considered the effects of the mine on total dissolved solids (TDS), dissolved oxygen (DO), metals, and pH. The Board is, due to insufficient information, unable to conclude whether metals are likely to pose a problem anywhere in the study area, including the International Boundary. With the possible exception of DO and metals, the Board concludes that none of those parameters will be changed enough to affect any water use downstream of the mine or at the International Boundary, in either the optimal or adverse case. Although there should be no significant change in DO concentrations in the Flathead River at the International Boundary, there is a possibility that DO concentrations could be reduced to harmful levels in bull trout spawning gravels due to lowered DO concentrations in groundwaters resulting from passage of groundwater through waste dumps.

Impacts on Biota. Development of the mine could affect algae in the creeks and the river particularly if there are changes in nutrient concentrations, temperature, or sediment deposition. The Board concludes that in the mine site area under the optimal case, there would be a significant increase in the amount of algae growing on the streambed. The diversity of species would decrease and the type of algae would change from small, single-celled forms, to larger and more visible filamentous types. The WQCSC NEL criteria for algal biomass would be more frequently exceeded locally and seasonally than at present. Under the adverse case in the mine site area, these predicted changes would be similar in kind but the effects would be greater.

At the International Boundary and for some distance downstream, under the optimal case, algal concentrations would increase significantly. This increase would occur to a greater extent under the adverse case. In either case, the increases would be smaller than at the mine site.

The Board concurs with the WQQC's prediction that increases in nutrient concentrations would likely cause corresponding increases in benthic biofilms (consisting primarily of periphyton) during low flow period, and that this would occur from the mine site to an unknown point some distance downstream of the International Boundary. It is not known whether these increases would be visible to the naked eye.

There could be increased algal growth below the outfalls of municipal wastewater treatment plants, all of which are located downstream of the confluence of the North and Middle Forks of the Flathead River, due to nitrogen contributions from the proposed mine and phosphorus from the outfalls.

The Board concludes that the mine would have a detrimental impact on the benthic macroinvertebrate populations within the mine site. Under the adverse case, the overall impacts would be more severe than under the optimal case. The severity of this impact would vary with locality and would diminish downstream.

Some degree of impact could occur at the International Boundary. In the adverse case, there would be slight to moderate affects on benthic macroinvertebrates. Under the optimal case, there would be major changes in the population structure of benthic macroinvertebrate populations downstream of the International Boundary.

There are a number of impacts associated with the development of the mine that could affect spawning and rearing habitats for bull trout and cutthroat trout in Cabin and Howell creeks. These include toxic levels of nitrogen compounds in groundwater, increases in filamentous algae that smother spawning areas, increases in sediment concentrations and deposited sediments, possible reductions in dissolved oxygen, alterations to surface water or groundwater flow, and changes in water temperature. Given the BRC's interpretation of the two cases defining the mine, the Board concludes that the virtual elimination of the bull trout populations from Howell and Cabin creeks is probable. However, given the optimal and adverse cases as defined by the Board, the effects on bull trout and other fish species in Cabin and Howell creeks are less easily predicted. The Board concludes that, with regard to its two cases, reduction in populations of bull trout and other fish species will occur but that there are uncertainties regarding the groundwater regime in the mine area and the related problem of toxic compounds of nitrogen. The Board concludes that under its adverse case there would be significant reductions in fish populations, but that under its optimal case the losses would be less.

The Board concludes that there will be some adverse effects on species closely associated with riparian habitats due to a reduction in the food base for some riparian animals. These effects may extend to the International Boundary. The Board notes that if maintained, the 90-meter (297 ft.) wide buffer strip that is required to be maintained along the banks of Howell and Cabin creeks would provide some protection to riparian habitats within the mine site area.

Impacts on Water Uses. Changes in water quantity, water quality, and biological resources due to the mine could have socio-economic impacts on the State of Montana. Based on information provided in the WQQC and BRC reports, WUC concluded that the apparent impact from the construction, operation, and reclamation of the proposed mine is limited to a loss of approximately 10 percent of the basin's bull trout population. The WUC cautioned, however, that the existing information was unsuitable for evaluating all impacts of the proposed mine on the waters of Flathead River Basin.

In a tabulated summary of potential impacts of the mine of socio-economic activities in the Flathead River Basin, based on the WQQC's and BRC's adverse cases, the WUC showed that non-fishing recreation would be affected in B.C., but considered that there was insufficient information to forecast an impact in this use in Montana. WUC also showed that some degree of impact is anticipated on the special designations applied to the North Fork of the Flathead River: namely, the Wild and Scenic River designation; Glacier National Park, for which the centerline of the North Fork of the Flathead River is the western boundary; and the Biosphere Reserve designation.

As directed by the Board, WUC estimated the potential loss in economic value to the State of Montana resulting from a reduction in the numbers of bull trout available to fishermen. Its assessment was based on the BRC's adverse case, which predicts the elimination of the bull trout population that is dependent on Howell and Cabin creeks for spawning sites. The BRC also states that approximately 10 percent of the bull trout population of the Flathead River Basin originates in these creeks.

Based on this analysis, the Board concludes that, from the standpoint of direct user values, the mine may cause an annual economic loss to the State of Montana of approximately \$300,000 to \$800,000 (1986 U.S. dollars) if the bull trout populations of Howell and Cabin creeks is eliminated. The Board recognizes, however, that although not quantified, losses associated with non-user values could increase the losses currently projected.

The special designations applicable to the North Fork of the Flathead River have been assigned by the United States Congress and by UNESCO. Their purpose has been to preserve and to protect the North Fork of the Flathead River. The State of Montana has provided a further element of protection to the North Fork of the Flathead River by classifying its waters as Class A-1, the state's highest water quality classification.

A literal interpretation of these designations and classifications would prohibit any activity that could impact the water and related resources. The Board recognizes, however,

that the pristine condition of the North Fork of the Flathead River has been compromised to some degree by historical and ongoing activities in the basin on both sides of the International Boundary. The Board also recognizes that any additional development on either side of the International Boundary has the potential to counteract the purposes and intent of the special designations. The Board has carefully considered the potential impacts of the mine on the water uses that are associated with the special designations. It concludes that the greatest potential for adverse impact is associated with the fishery resources.

As stated above, the Board has not been able to determine the proportion of the fish population that could be lost; however, any diminution of the habitat that supports the fishery resources of the North Fork of the Flathead River would be contrary to the intent of the special designations. In the Board's opinion, the potential for loss of fish habitat due to the proposed mine is greater than that associated with current activities in the North Fork of the Flathead River Basin.

The Board concludes that there is less risk to other water uses associated with the special designations such as recreation, aesthetics, and ecological integrity due to sedimentation, turbidity, nutrients, and increases in periphyton growth resulting from the proposed mine.

Extreme or Unusual Events. There is an unknown but potential risk of failure of waste dumps, settling ponds, or the tailings pond. Such a failure could significantly affect water quality and biological resources at and downstream from the International Boundary. Depending on the magnitude and type of failure, the effects on some aquatic systems could be long-term and possibly irreversible. The impact would be due primarily to sedimentation deposition and damage to aquatic and terrestrial biological resources. Such degradation would adversely affect the water uses associated with the special designations applicable to the North Fork of the Flathead River. While it is recognized that the probability of such events is low, the Board acknowledges that, over the life of the mine, the possibility of a failure of some feature or safeguard at the mine does exist.

REFERENCE CITED

Flathead River International Study Board. 1988. Final Report to the International Joint Commission assessing the potential impacts of the proposed Sage Creek Coal Limited mine on water quality, water quantity, biological resources, and water uses in the Flathead River system of southeastern British Columbia and northwestern Montana. International Joint Commission. Ottawa, Canada, and Washington, D.C.

APPENDIX F
FLATHEAD BASIN COMMISSION

TESTIMONY AT THE
INTERNATIONAL JOINT COMMISSION HEARING
ON THE REPORT OF THE FLATHEAD RIVER INTERNATIONAL STUDY BOARD
KALISPELL, MONTANA, SEPTEMBER 22, 1988

Mr. Chairmen, and members of the Commission, my name is Brace Hayden and I am the Executive Director of the Flathead Basin Commission.

The Flathead Basin Commission was created to "protect the existing high quality of Flathead Lake's aquatic environment; and the waters that flow into and out of, or are tributary to the lake." The 17 members of the commission include: state, federal and tribal land managers in the basin and three citizen members appointed by the Governor.

The Province of British Columbia has a liaison to the Commission, a position that is currently held by Mr. Robert "Vic" Farley, who is Special Advisor Constitutional Affairs, Federal-Provincial/International Relations in the Office of the Premier. The Commission respects the wise counsel that Mr. Farley and his predecessor as liaison, Mr. Peter Heap, have provided.

The Commission's duties include:

- monitoring the basin's natural resources
- encouraging cooperation among basin land managers
- holding public hearings on the environment and economic conditions of the basin
- supporting economic development without compromising the basin's aquatic systems,
- making recommendations to the legislature regarding the preservation of the basin's aquatic resources and
- promoting cooperation between Montana and British Columbia on resource development in the Flathead Basin

An underlying reason for adding this last responsibility was an awareness on the part of the Montana legislature that activities in the Canadian portion of the Flathead's drainage can have a significant effect on the quality of the Flathead River System, including Flathead Lake.

Examples of Commission activities include its successful lobbying effort for legislation that allows counties to restrict the use of phosphate detergents where lake eutrophication is a problem, and adoption by the

Montana Department of Health and Environmental Sciences of a rule requiring phosphorus removal to a standard of 1 mg/l at municipal wastewater treatment plants discharging to Flathead Lake or its tributaries. The Commission subsequently encouraged communities that discharge wastewater into Flathead Lake or its tributaries to add, in an expeditious manner, tertiary treatment for phosphorus removal so as to meet the 1 mg/l standard and thus minimize further degradation of the lake.

The Commission has also been instrumental in establishing and seeking funding for a Water Quality Monitoring Master Plan in the Flathead Basin. This plan integrates water quality monitoring by area agencies, provides a comprehensive assessment of changes in water quality, and identifies the probable reasons for any changes.

In 1985, the Commission urged U.S. Senator Max Baucus and Montana Governor Ted Schwinden to seek an IJC study of the proposed Cabin Creek coal mine. We were also successful in having the Montana State Legislature appropriate the funding necessary to allow state scientists to participate in the effort. One of the Commission's members, Mr. Jerry Sorenson of Lake County, served on the Flathead River International Study Board's Water Uses Committee.

The Flathead Basin Commission has recently begun to work towards solutions to such problems as the need for effective land use planning in the valley, the conflicts inherent in the management of Flathead Lake's water levels; and such nonpoint source water quality problems as logging activities, home construction around the lake, and agriculture. The Commission believes that the solution to the Flathead Basin's water quality problems lie in addressing all of the causes, rather than concentrating our energies only on those point source problems that are the easiest to solve.

In late 1986, the Commission began a formal public education effort regarding threats to the basin's water quality. In establishing this program, we recognized that land management and regulatory agencies have identified the steps that need to be taken to protect the Flathead's water resources. Strong public understanding, and hence support, is what is now needed if these water management decisions are to be implemented. Building public support for protecting basin waters is one of the Commission's primary objectives.

On September 15, 1988, after analysis and discussion, the Commission voted to oppose the proposed Cabin Creek coal mine. Our reasons are that we do not believe that the water and fishery impacts of the mine, as detailed in the Investigative Board's Report, are sufficiently mitigable to protect the aquatic resources of the North Fork area; and that development of this large, open pit coal mine in close proximity to the Waterton-Glacier International Peace Park violates the important economic and ecological values that this area represents to both the United States and Canada.

The International Joint Commission is to be commended for the high quality of their report. It is testimony to the hard work and integrity of the many scientists who worked on the Investigative Board, and its various committees and task forces. The Commission notes that the

breadth, accuracy, and specificity of the analyses presented were impaired by the limited baseline data available, and by the incomplete nature of the mine design and engineering plans. This is not a criticism, but an observation, as we acknowledge the limitations in the terms of the reference under which the IJC instructed the Investigative Board to operate. We are concerned, however, that premine data and engineering deficiencies may have resulted in the Board possibly understating potential impacts.

The terms of the reference constrained the scope of the Board's analysis to three principal areas: water quality and quantity, water uses, and fisheries. But certainly the mine would have broader impacts than these that also require international consideration should British Columbia allow the mine proposal to proceed to phase III. These include the socioeconomic impacts of a major industrial development adjacent to the park complex, impacts to endangered species and air quality, and the effects of the proposed mine on the areas rich tourism investments both in the United States and Canada. Should a decision be made to proceed to phase III, we strongly encourage the IJC to continue and expand the scope of the reference to include these broader considerations.

Let me now briefly comment on a few of the findings noted in the Board's report or that of its subcommittees.

We are disturbed by the differences between the mine impact scenarios for the optimal and adverse cases that existed between the Board's report and that of the Biological Resources Committee (BRC). As stated on page 112 of the Board's report, this assessment is based on strict adherence to the phase III mine plan and the values or limits for water quality under the phase III permitting process. The BRC however did not accept these conditions in their assessment because, "adherence to a mine plan is without precedent in southeastern British Columbia." Such differences in findings between the Board and one of its committees raises doubts about the concensus process followed by the Board regarding the predicted biological impacts from the proposed mine.

Similarly, the Water Quality and Quantity Committee (WQQC) and the BRC both predicted significant sediment increases in streambottom materials in Howell and Cabin creeks that would persist for many years. The Board modified these predictions and concluded that there would be some increases in sediment in areas of the stream, but most would be washed out during freshets. This in effect, tempered the committees' findings.

The Flathead Basin Commission notes that incubating bull trout eggs are extremely sensitive to sediment, and that juvenile bull trout rely on clean, unsedimented cobbles for rearing. Based on the WQQC's predictions of sediment increases under the adverse case, virtually no egg survival would be possible in the gravels of Howell Creek.

The BRC predicted the "virtual elimination" of bull trout in Howell and Cabin creeks, and serious impacts on cutthroat and other species. Causes of the elimination of bull trout would include "increases in suspended and deposited sediments, toxic compounds of nitrogen, changes in water temperature, flow modifications, and degradation of food supply

physical habitat" (p. 156). However, the Board charges that in making these findings the BRC did not adhere to the definition of the optimal and adverse cases of the mine. In discussion with members of the BRC, the Commission finds that the BRC's definition didn't differ substantially from the interpretation of the two cases by the other committees. Both the WQQC and BRC predicted sediment increases under the adverse case that would be sufficient alone to eliminate bull trout in Howell Creek. Thus, we find the Board's prediction of the impacts on the fishery, as described on pages 157 and 158 of their report, to perhaps be an understatement.

The Commission is also concerned that the IJC assessment may be understating the proposed mines impacts in that it analyzed only the impacts of the 21 years of mining provided for in the phase II mine plan, when in fact 41 years of coal reserves exist at the site. Long-term impacts could be considerably more severe than reported.

The Commission notes the Board's conclusions that phosphorus and nitrogen loading of Flathead Lake by mine activities are not predicted to have a significant impact on the rate of algal growth in the lake (p. 154). Nevertheless, we are concerned that any additional input of elements will ultimately speed up the rate of lake entrophication. Slowing the rate of entrophication is a major concern of the Flathead Basin Commission.

The Flathead Basin Commission has been active in the fight to reduce the amounts of biologically available phosphorus coming from Flathead Basin wastewater treatment plants and septic systems. Evidence of this fact is the effort to impose a 1 mg/l phosphorus standard for wastewater treatment plants discharging into Flathead Lake or its tributaries and the phosphorus detergent ban in Flathead and Lake counties. We were thus dismayed to read (p. 154) that under the adverse case mine scenario, algal production could be enhanced below outfalls from municipal wastewater treatment plants in the basin. This would clearly be a step backwards for the health of the lake.

The Commission is pleased by the commitment of British Columbia to require a 90 meter wide buffer strip to be maintained along the banks of Howell and Cabin creeks. We recognize that this is an unprecedented degree of streamside protection for a mining venture in the province. British Columbia's requirement, however, draws attention to the fact that the Cabin Creek coal mine, as currently proposed, would most likely not be allowed to be constructed were it located within the State of Montana. The Montana Strip and Underground Mine Reclamation Act states, in part, that if lands proposed for mining or adjacent lands have certain special, exceptional, critical, or unique characteristics a permit may not be granted (82-4-227(2), M.C.A.). These characteristics include: lands having special, exceptional, critical or unique biological productivity, ecological fragility, or ecological importance. The presence of important bull trout spawning and rearing habitat in Howell Creek and the existence of grizzly bear and gray wolf populations and habitat on the mine site and/or neighboring lands, including Glacier Park, make it very likely that such denial criteria would be found to be present were the mine located only a few miles further south.

Another undesirable feature of the mine is the leaving of open pits after mining has been completed. This would continue any visual impact of the mine long after mining was completed. A basic reclamation requirement in Montana's regulatory program is to backfill and grade the disturbed area to the approximate original contour of the land and to eliminate all highwalls. The leaving of open pits as proposed in the phase II mine plan would probably not meet this requirement. Furthermore, we find the presence and impacts of these enormous, permanent pits to be inconsistent with the purposes and viability of the adjacent International Peace Park, Wild and Scenic River, Biosphere Reserve, and a nominated World Heritage Site.

The Flathead Basin Commission is also concerned about the risk of potential failure of waste dumps, settling ponds, or tailings at the mine site that the Board acknowledges is a possibility, however a remote one. We note that on at least two occasions in recent years such failures have in fact occurred at mines in the Elk River Valley to the north of the proposed Cabin Creek mine. Should such failures occur adjacent to Howell and Cabin creeks, the severity of the mine's impacts to the water quality and aquatic systems of the North Fork could be far more serious than those described in the Board's report.

Lastly, the Commission finds that the mitigation suggested in the Board's Supplemental Report is in some cases untested and in many cases unprecedented under British Columbia's mine regulatory program. It is noted that the costs for implementing all of the additional studies and mitigation suggestions in the Supplemental Report would make Cabin Creek a very expensive coal mine to bring on line, perhaps to the point of being uncompetitive with other British Columbia coal mining ventures.

The Flathead Basin Commission concurs with Governor Schwinden's suggestion that if the provincial government allows the mine to go forward that an International Board of Control be organized to oversee the studies, mitigation and monitoring suggested in the Supplemental Report. This International Board of Control should have sufficient authority to close down the mine if problems in design or operation occur. The North Fork is simply too sensitive an area for anything short of state-of-the-art mining operations.

The Commission strongly urges, however, that the IJC members recommend to their respective governments that the Cabin Creek coal mine not be built and that assessment of alternatives to constructing the mine begin immediately including, if necessary, helping facilitate location of an alternative source of coal in a less environmentally sensitive area. The Commission also urges that there be efforts by the IJC and its superiors to begin discussion regarding a bilateral agreement on the type of industrial development that are and are not consistent with the environmental and aesthetic characteristics of the Waterton-Glacier area. The Commission would certainly expect Canada, and in particular the citizens of British Columbia, to raise similar concerns were an open pit coal mine proposed on the Montana side of the 49th parallel and adjacent to the Waterton-Glacier complex.

We also concur with the Governor's statement that in the spirit of compromise and fair play, that the United States be more responsive to Canadian environmental concerns with regard to such U.S. problems as the generation of acid rain precursors emitted from U.S. coal-powered electrical generating plants.

The Board's report correctly draws attention to the symmetry issue; that is, that there are activities in the Montana portion of the Flathead Basin that also impact or potentially impact the quality of the North Fork or of Flathead Lake. These include logging activities, road construction, septic effluents, and potential oil and gas development. The Commission has and will continue to seek methods to minimize the impacts from such sources by encouraging all land management agencies to adhere to best management practices, by fostering greater cooperation between regulatory agencies and the private sector, and by recommending outright denial of projects whose impacts would violate the Glacier-Waterton area's world-class environmental amenities.

In closing, the Commission extends to British Columbia and all Canadians an invitation to work with its members to protect the resources of the North Fork and other parts of the Flathead Basin.

Thank you for the opportunity to comment.

APPENDIX G

Model Rule for the Regulation of Phosphorus Compounds Used for Cleaning Purposes[1]

Policy

This model rule is designed to enable counties to protect water quality and aquatic ecosystem by reducing the amount of phosphorus entering natural lakes.

Application and Composition of this Rule

1. This rule may be adopted by any county if:

   a) The county has a natural lake, whether or not it is fitted with a dam, for which the Department of Health and Environmental Sciences or the governing body of the county has determined that eutrophication enhanced by human activity is occurring and that phosphorus is the limiting factor.

   b) Other efforts are being taken in the county to reduce the amount of phosphorus entering surface waters.

2. Any ordinance adopted by the governing body of a county must contain the standards designated in this model rule which are in effect at the time of adoption of the county ordinance.

3. Any ordinance adopted by the governing body of a county must be enforced by the county.

4. This rule consists of policy, application and composition, definitions, prohibitions and exceptions, and penalties.

1 This model rule was prepared by the DHES-Water Quality Bureau as required by House Bill 711, Session Laws of 1985.

Definitions

In this sub-chapter the following terms shall have the meanings indicated below:

1. "Chemical water conditioner" means a water softening chemical or other substance containing phosphorus which is intended to treat water for machine laundry use.

2. "Commercial establishment" means any premises used for the purpose of carrying on or exercising any trade, business, profession, vocation, or commercial or charitable activity, including but not limited to laundries, hospitals, hotels, motels, and food or restaurant establishments.

3. "Household cleaning product" means any product including but not limited to soaps and detergents used for domestic or commercial cleaning purposes, including but not limited to the cleaning of fabrics, dishes, food utensils, and household and commercial premises. Household cleaning product does not mean foods, drugs, cosmetics, or personal care items such as toothpaste, shampoo, or hand soap.

4. "Person" means any individual, proprietor of a commercial establishment, corporation, municipality, the state or any department, agency or subdivision of the state, and any partnership, unincorporated association, or other legal entity.

5. "Phosphorus" means elemental phosphorus.

6. "Trace quantity" means an incidental amount of phosphorus which is not part of the household cleaning product formulation, and is present only as a consequence of manufacturing, and does not exceed 0.5 percent of the content of the product by weight expressed as elemental phosphorus.

Prohibitions and Exceptions

1. Except as provided, no household cleaning product may be distributed, sold, offered, or exposed for sale if it contains a phosphorus compound in concentrations in excess of a trace quantity.

2. No dishwashing detergent may be distributed, sold, offered, or exposed for sale if it contains a phosphorus compound in excess of 8.7 percent by weight expressed as elemental phosphorus.

3. No chemical water conditioner which contains more than 20 percent phosphorus by weight may be distributed, sold, offered, or exposed for sale.

4. Cleaning agents used for industrial processes, cleaning food and beverage processing equipment, cleaning medical or surgical equipment, or cleaning dairy equipment are exempt from the provision of this rule.

Penalty

1. A person involved in the sale or commercial distribution of any phosphorus compound prohibited by an ordinance adopted pursuant to this rule must be notified by the county and must be given 30 days from receipt of such notice to comply with the ordinance. Failure to comply with the ordinance following this 30-day period is a misdemeanor. Each day of violation is a separate offense.

2. The penalty provided for in subsection #1 above applies only to persons engaged in the sale or commercial distribution of prohibited phosphorus compounds. The county may not prosecute or otherwise penalize a person for using a phosphorus compound regulated by an ordinance adopted pursuant to this rule.

APPENDIX H

Glossary

Advanced Waste Treatment. Methods and processes that will remove more contaminants from wastewater than are usually removed in present-day conventional treatment plants. The processes may be physical, chemical, or biological. Examples of advanced waste treatment are granular carbon absorption, nutrient removal, reverse osmosis, electrodialysis, and ion exchange.

Algae. Primitive nonvascular plants, having one or many cells, usually aquatic and capable of fixing carbon dioxide by photosynthesis.

Anthropogenic. Of, relating to, or resulting from the influence of human beings on nature.

Aquatic. Plants or animal life living in, growing in, or adapted to water.

Aquifer. A water-bearing stratum of permeable rock, sand, or gravel.

Available Nutrient. That portion of any element or compound (such as phosphorus and nitrogen) in the soil that can be readily absorbed and assimilated by growing plants.

Avoided Cost. The cost that a power company would have to pay in lieu of energy production based on historic conditions and generally accepted industry standards, for a small or alternative energy producer's product.

Baseline. A collection of data ideally assembled prior to the introduction of change, such as a new activity, in order to compare the effects of the added event to previous conditions.

Best Management Practices (BMPs). Methods, measures, or practices to prevent or reduce water pollution, including, but not limited to, structural and nonstructural controls and operation and maintenance procedures. BMPs may be applied before, during, or after pollution-producing activities to reduce or eliminate the introduction of pollutants into water bodies.

Biochemical Oxygen Demand (BOD). The quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. Waste discharges containing high levels of BOD will deplete oxygen supplies in receiving waters.

Biological Availability. Refers to the form that a substance or compound can take that can be readily used for plant or animal growth. Depending on their chemical structure, certain compounds are more available for plant growth than others.

Biota. The flora and fauna of a region.

Buffer Strip. Strips of grass or other erosion-resistant vegetation between a waterway and an area of more intensive land use.

Data Base. A collection of information kept in accessible form for purposes of research, comparison, and analysis.

Dissolved Oxygen (DO). The amount of free oxygen dissolved in water and readily available to aquatic organisms. It is usually expressed in milligrams per liter or as the percent of saturation. Low concentrations can result from the decomposition of excessive amounts of organic matter, a process that consumes DO and therefore limits aquatic life.

Effluent. Liquid waste attributed to human waste, i.e., sewage arising from various uses of water.

Erosion. The wearing away of a land surface by wind or water. Erosion occurs naturally from weathering or runoff, but can be intensified by land clearing practices. Sheet erosion occurs when water runs off in unbroken layers over the soil surface; rill erosion occurs when water runs off in incisions less than 12 inches deep through the soil; and gully erosion results in trenches deeper than 12 inches in the soil.

Eutrophication. The addition of nutrients to a body of water. This occurs naturally as part of the normal aging process of many lakes; however, the process may be accelerated by human activities that result in excessive nutrient inputs that promote abundant growth of algae and other aquatic plants. As these die and decompose, much of the dissolved oxygen in the water is consumed, making the lake uninhabitable for the previous diversity of fish and other aquatic life.

Groundwater. The supply of fresh water that forms a natural reservoir under the earth's surface.

Groundwater Recharge. The natural renewal of groundwater supplies by infiltration of rain or other precipitation through the soil.

Heavy Metals. Metallic elements such as mercury, chromium, cadmium, arsenic, and lead, with high molecular weights. At low concentration, they can damage organisms; heavy metals tend to bioaccumulate in the food chain.

Hydrograph. A graph of the rate of runoff (discharge) plotted against time for a point on a channel or hillside.

Hydrologic. Dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

Leaching. The removal of nutrients, chemicals, or contaminants from the soil by water movement through the soil profile.

Limnology. The scientific study of physical, chemical, meteorological, and biological conditions in fresh waters.

Lotic. Of, relating to, or living in actively moving water.

Mesotrophic. Descriptive of lakes in transition from oligotrophic status toward eutrophic. They are still generally pristine, but fish species are mixed, nutrient levels are higher, and water is not quite as crystal clear.

Nitrogen. A chemical element, commonly used in fertilizer as a nutrient, which is also a component of animal wastes; as one of the major nutrients required for plant growth, it can promote algal blooms that cause water body eutrophication if it runs off or leaches out of the surface soil. Available nitrogen is a form that is immediately usable for plant growth (NO_3 or NH_4).

Nonpoint Source. A diffuse source of water pollution that does not discharge through a pipe, such as agricultural or urban runoff, or runoff from construction activities.

Nutrient Budget. The quantity of a given element or compound available for plant productivity over time. Changes in plant productivity are directly related to changes in the nutrient budget.

Nutrient Loading. Increases in the nutrient budget attributed to either increases from human-related or natural events.

Nutrients. Elements or substances such as nitrogen and phosphorus that are necessary for plant growth. In water bodies, large amounts promote excessive growth of aquatic plants and cause eutrophication of the water body.

Oligotrophic. Descriptive of crystal-clear lakes characterized by cold water fish species, low nutrient content, and generally pristine features.

Pelagic. Of, relating to, or living or occurring in the open sea.

Phosphorus. One of the primary nutrients required for the growth of aquatic plants and algae. Phosphorus is often the "limiting" nutrient for the growth of these plants (see nitrogen).

Piscivores. Organisms that feed on fish.

Point Source. A discernable source of pollution, such as pipes, ditches, channels, wells, containers, concentrated animal feeding operations, or other vessels.

Redd. The spawning ground or nest of various fishes.

Revegetation. The planting of ground cover on highly erodible and marginal lands as a means of preventing further erosion.

River Hydrograph. The pattern of a river or lake expressed as inflow and outflow ratios, such as cubic feet per second; and containing temperature, chemical, and other expected characteristics.

Runoff. Water from rain, snowmelt, or irrigation that flows over the ground surface and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Secchi Disk Depth. The exact depth at which a disk, with the flat surface horizontal, disappears when lowered into water on a calibrated line. It is expressed as depth in meters, and is half the distance light travels to the disk and back up to the observer's eye.

Secondary Treatment. May be defined as that process or group of processes capable of removing virtually all floating and settleable solids, generally from 80 to 95 percent of the five-day biochemical oxygen demand, and a similar level of removal of suspended solids in untreated wastes. The equivalent treatment may generally be defined as that process or group of processes achieving maximum practicable removal of solids, oils, grease, acids, alkalis, toxic materials, bacteria, taste and odor-causing materials, color, and any other objectionable constituents contained in untreated waste to produce an effluent equivalent to that obtained from secondary treatment facilities in current use for any specific category of industrial waste (properly designed and operated sewage lagoons are acceptable secondary treatment facilities for domestic wastes).

Sediment. Solid material (such as silt, sand, or organic matter) that has been moved from its site of origin and has settled to the bottom of a watercourse or water body. Excessive amounts of sediment can clog a watercourse and interfere with navigation, fish migration, and spawning. If disturbed, sediment can be resuspended in the water column, where it contributes to turbidity.

Suspended Solids. Solids floating in the water column that generally impart a cloudy appearance (turbidity) to water, sewage, or other liquids. Suspended solids are measured as the amount of material retained on standard filters.

Tailings. Residue of raw materials or waste separated out during the processing of mineral ores.

Tertiary Treatment. See Advanced Water Treatment.

Trophic Status. The descriptive phase of a lake: oligotrophic, mesotrophic, eutrophic, or somewhere in between. Flathead Lake currently is described as oligo-mesotrophic.

Turbidity. Haziness or cloudiness in water because of suspended silt or organic matter.

Watershed. The area of land that drains into a particular watercourse or water body.

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The Flathead Basin Commission was established by the 1983 Montana Legislature to protect the Flathead Basin's aquatic environment, waters that flow into or out of Flathead Lake, and other natural resources of the Basin.

The Commission is made up of representatives of federal, state, local, tribal and Canadian agencies, as well as private and citizen interests. The Commission is charged with the following tasks:

* monitoring the Basin's natural resources;
* encouraging cooperation among land managers;
* holding public hearings on the condition of the Basin;
* supporting economic development without compromising the Basin's aquatic system;
* promoting cooperation between Montana and British Columbia on resource development in the Flathead Basin;
* making recommendations to the Legislature regarding the preservation of the Basin's aquatic resources.

The Flathead Basin Commission maintains offices at the following locations:

Office of the Governor
Capitol Station
Helena, Montana 59620
(406) 444-3111

723 Fifth Ave. East
Room 207
Kalispell, Montana 59901
(406) 752-0081

The Commission's meetings are held throughout the Flathead Basin. Public participation in all Commission activities is encouraged.

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